TECHNOLOGY DEPARTMENT

Power Generation

and POWER PLANT ENGINEERING

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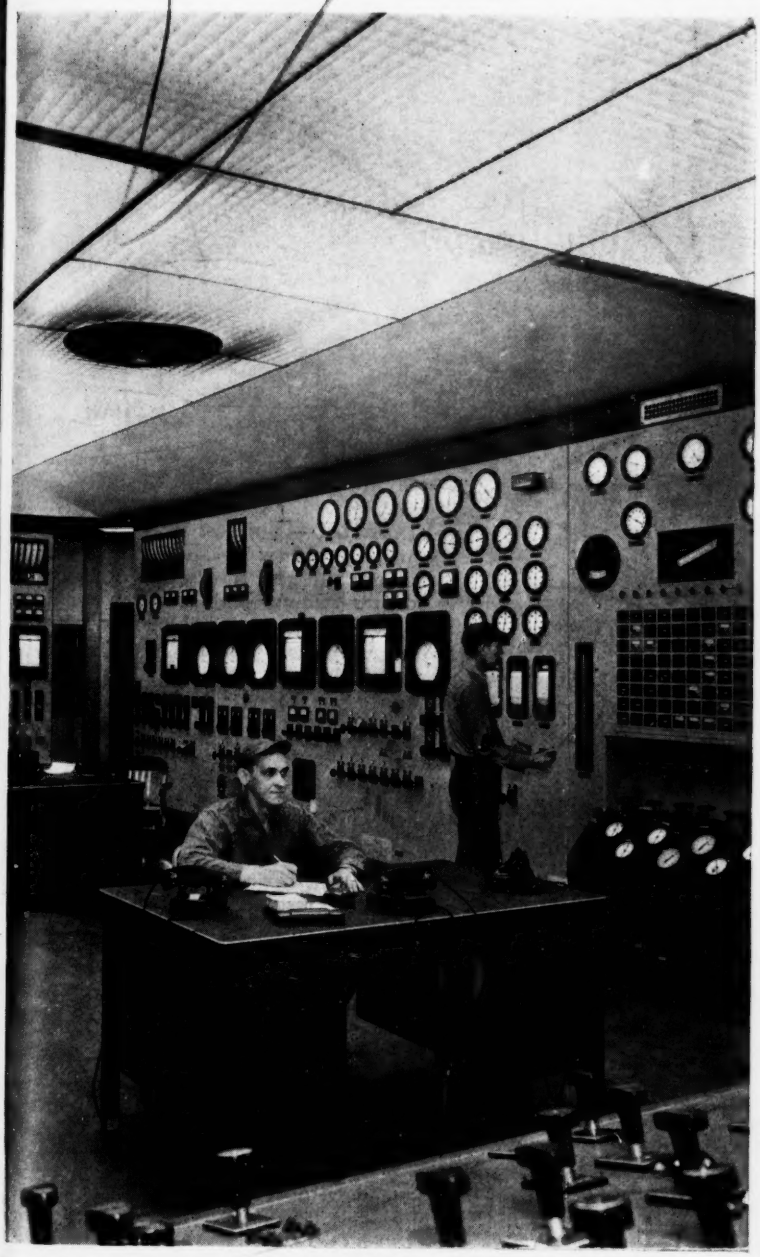

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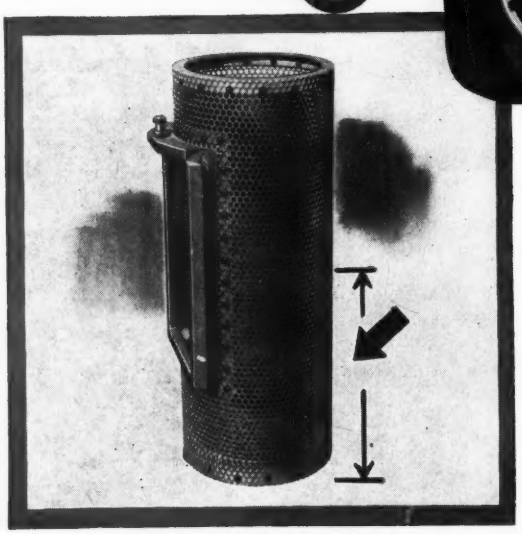
• • •

COVER: View of a portion of the control room at Sewaren Generating Station of the Public Service Electric and Gas Co. at Sewaren, N. J.

For Power Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

THE NEW Elliott

✓R v.52 July-Dec. 1949



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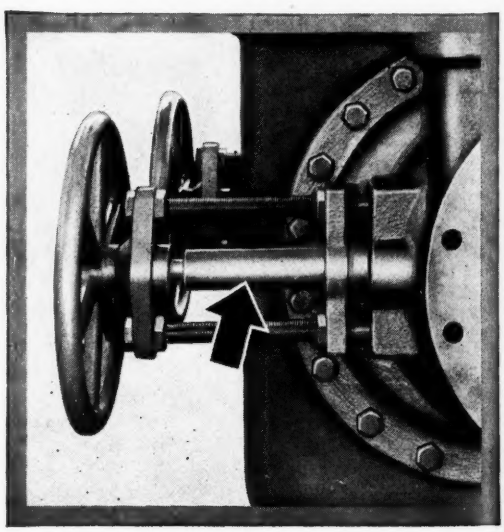

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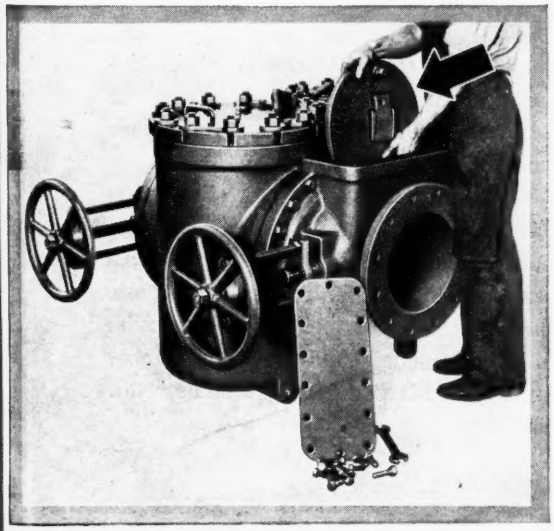
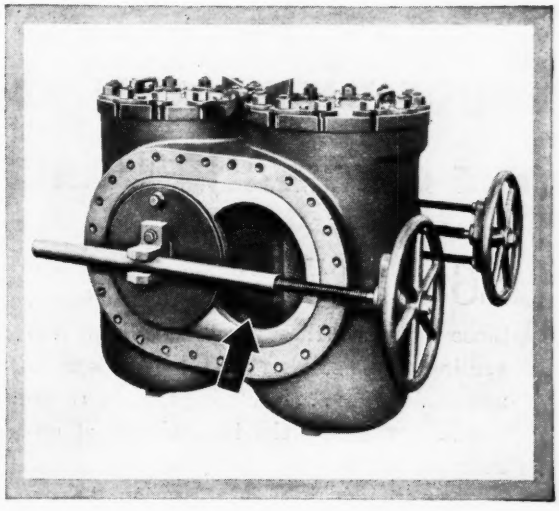
lead the field in *many new features*

CHECK over the advantages in this new Elliott Type A Twin Strainer—designed to minimize pressure drop . . . to make cleaning easier, quicker, and less often . . . to simplify mechanical maintenance . . . and to add years of service life.

Elliott Twin Strainers are built in a complete line of sizes 1″ to 24″, for 125 lb. pressure and 1″ to 12″ for 250 lb. pressure. Many new developments besides those shown here, are described in the bulletin, sent at your request. Mail the coupon.

EASILY REMOVABLE VALVE DISC enabling replacing of valve disc ring without dismantling valve. Twin Strainers have gate valves, which brush off their valve seats before sealing.





NO LIQUID TOUCHES VALVE SCREW THREADS because the valve shaft, and not the valve screw, is in contact with the liquid.

A-298PG

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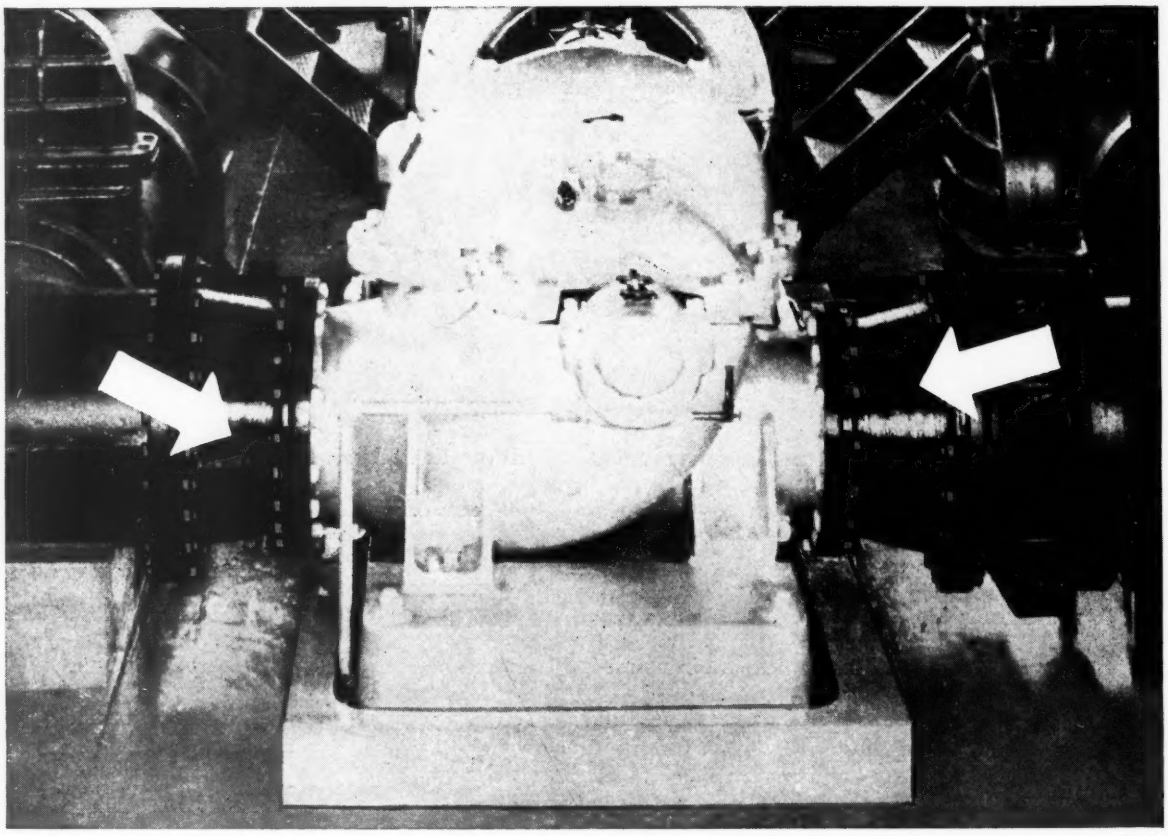

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Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

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Subscription Information—Published Monthly. Prices: United States and Possessions one year $10.00, Canada one year $11.00. Other countries one year $12.00. Single copies $1.00. Changes of address should give both old and new address and reach us by 15th of month to be effective with following month's issues. The Annual Index is furnished as a part of the December issue.

Power Generation

July 1949

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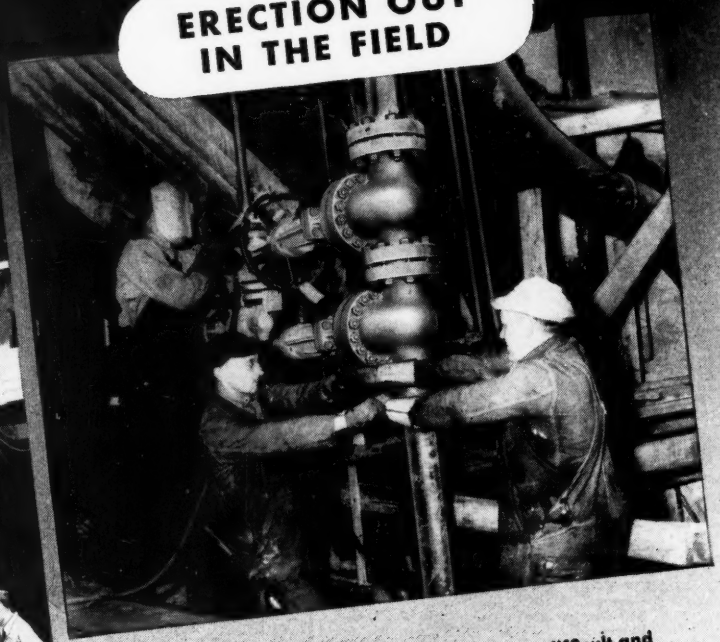
YOU GET BETTER PIPING

INSIDE and OUT

PREFABRICATION IN THE SHOP

ERECTION OUT IN THE FIELD



Because Midwest has erected some of the most difficult and exacting piping jobs out in the field, in addition to having prefabricated them in the shops, we have a clear, competent view of piping problems from every angle.

Our Fabricating Department works closely with the Contracting Department . . . continually seeking ways of making their job easier, less costly, and higher in quality. The Contracting Department is always ready to make practical suggestions for improving prefabricated piping subassemblies. It is in constant and intimate touch with piping users in all types of industry. Changes in needs—changes in thinking are quickly relayed to the whole Midwest organization.

The net result to you is better piping whether you want a simple pipe bend . . . a series of complex prefabricated subassemblies . . . or a difficult piping job completely erected.

MIDWEST PIPING SERVICE IS NATION-WIDE

4 PLANTS ARE BETTER THAN 1

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ENGINEERS' PREVIEW

ACTUAL EXTENT of iron ore deposits in Ungava and Labrador is a multi-million dollar question in steel circles. Before the full potential of the deposits is determined, geologists must solve many of the mysteries of that bleak land. They hope to prove that in northeastern Quebec and Newfoundland's Labrador there is as much ore as in five virgin Mesabi ranges. Minnesota's fabulous Mesabi Range on Lake Superior, reports the *Associated Press*, held 2,500,000,000 tons when discovered in 1892. The only known larger deposits are in Brazil and Russia. Canada's great undeveloped ore formation is deeply encrusted, sprawled over an area 300 miles long—some say 600 miles—and 50 miles compared with Mesabi's 112-mile single strip. If it turns out that these Labrador deposits are richer than Mesabi, the effect on the nation's steel industry can readily be imagined.

★ ★ ★

A NUCLEAR SCIENTIST is a man standing in a field in absolute darkness, with thousands of baseballs around him on the ground. Somewhere in the field, invisible to him, is a barn with only one window and some kind of animal inside.

The man picks up a ball and throws it in any direction. If, by some chance, it goes through the barn window and hits the animal, and then bounces back out again so that the man can catch it in the darkness, he may try to identify the animal by smelling the ball.

Dr. Robert D. Fowler, nuclear scientist from The Johns Hopkins University, gave this definition of a nuclear scientist to a group of government officials at a recent symposium, as reported by *Associated Press*.

★ ★ ★

ANOTHER OIL PIPELINE, expected to be one of the largest and longest in the United States, is being planned to carry crude oil from the Longview, Texas area approximately 1000 miles northeast to Lima, Ohio. For most of the distance the big 22-in. pipe will be operated as a common carrier and its full capacity to Cincinnati will be about 150,000 barrels daily and to the Lima terminus about 140,000 barrels. The project includes construction of seven main pumping stations, two spur-line pumping stations and four oil terminals. The line will cross the Mississippi and Ohio Rivers. Completion is scheduled for early 1951 by the Mid-Valley Pipe line Co. recently organized to build it, under Ohio laws, by Sun Oil Co. of Philadelphia and Standard Oil Co. of Ohio.

★ ★ ★

OPERATION BLACKBOARD, first major project to use television for a new kind of visual education in the classrooms of many schools simultaneously, was scheduled to be launched in public, parochial and private schools in the Philadelphia area in March. Sponsored jointly by the Philadelphia Board of Education, Philco Corporation and television station WPTZ, Operation Blackboard consisted of a series of 39 educational programs to be telecast three times a week. Students themselves were scheduled to take part in most of the shows, which would cover everything from science to current events to baseball, and would utilize the services of many authorities in various fields.

IN THE Science Section of a recent Sunday edition, *The New York Herald Tribune* finally woke up to the existence of a mercury turbine installation at Hartford, Conn.—after 20 years of development and constant discussion of it in the technical and business press. To cap the climax, the capacity of the mercury installation was given as "15,000 kilometers." So reports our good friend, C. O. von Dannenberg, who says this reminds him of the Britisher who asked for a "kilometer" of sausage when he meant "kilogram" and the butcher replied: "I can make it for you if you give me time."

★ ★ ★

EVERYBODY should have heard by this time that the mouse milk at $10,000 a quart, referred to in EP, January 1949 issue, has played an extremely vital role in the recent isolation of the breast cancer virus in mice. These mice were housed in a "mouse dairy," probably the only one of its kind on such a scale in the world. Located high in the College of Physicians and Surgeons Building at the Columbia-Presbyterian Medical Center in New York City, the dairy contained more than 10,000 mice throughout the duration of the 12-year-old project. Thousands of mice are still milked regularly with the aid of a specially designed miniature suction pump, each mouse yielding only 1 cc of milk. The laboratory is air-conditioned to maintain 72 F, special lights shine for 12-hours each day, and the mice get their highly nutritious food at the same hour every day. The mice receive much better care than most people. They have to, explain the dairy technicians, because any early disease would destroy the experiment, for cancer usually is a disease of adult life.

★ ★ ★

NEW TERMINAL DEGREE for practicing engineers, to be called the "Engineer" degree, has been approved at the Massachusetts Institute of Technology and it is planned to award it for the first time at the Institute's Commencement this June. The degree "Engineer," with the field of specialization designated, will require about two years' study following a bachelor's degree in any of the Institute's various engineering departments. It is intended to fill an educational need for the development of professional engineering competence at a higher level than is ordinarily represented by the Master of Science degree.

★ ★ ★

ANYBODY WHO has ever owned land, now owns land, or expects to own land, will be vastly instructed and simultaneously entertained by an interesting book entitled "Your Land Surveys, Maps and Titles" by Fred C. Morris of the Department of Civil Engineering of the Virginia Polytechnic Institute. This has recently been published as Engineering Experiment Station Series Bulletin No. 71 and can be obtained from Virginia Polytechnic Institute, Blacksburg, Va. for 75c per copy. In non-technical language, it reviews the entire subject of land survey and how maps are made, in order to explain how conflicts originate over ownership of land and how they can be prevented by certain procedures that the author advocates for strengthening titles and simplifying transfers of land.

NEW FLAME-RESISTING oil tank has been developed for the U. S. Navy. It is capable of withstanding fire and temperatures of 2,000 F. An outer covering, in which American-made rubber is combined with other materials, provides this unusual resistance to heat and flames. The firm that developed it states it is bullet-sealing, and may be applied to gasoline tanks and other containers of volatile fuels.

★ ★ ★

MORE ON MAP MAKING—photogrammetry is a relatively new science, the science of obtaining measurements by means of photographs. This is done both by photographs taken on the ground and those taken from the air. The Sixth International Congress on Photogrammetry was held at The Hague, Netherlands, in September 1948 and a very full account of it, with details of many phases of the subject and how it is used, are given in the *Engineering Experiment Station News* of the Ohio State University, Volume XXI, No. 1.

★ ★ ★

BRAIN TEASER:—Before we abandon the "inverted check" (in these columns, that is) we ought to call attention to a very interesting letter from D. E. Winemiller, consulting engineer, of Cleveland. Somewhat of an amateur mathematician, Mr. Winemiller points out that there is a general type of problem of this kind. When it is explicitly stated or implied that the unknowns are restricted to positive integral values, the system of equations reduces to a single linear equation in two unknowns restricted to positive integral values, a Diophantine equation, as encountered in the Theory of Numbers. Mr. Winemiller shows the way in which these equations are applied to the inverted check problem. He then gives four other problems of the same general type and many of these, too, are probably well known to professional mathematicians.

While we cannot devote further space in these columns to discussions of mathematics of this type, we shall gladly put any reader in touch with any of the other readers who have commented on the Brain Teaser. Many power engineers are not only good mathematicians but make a hobby of it and might be interested in making contact with others of similar interests. When we started this brain teaser business, we had no idea there were so many of them, nor that we would stir them up like this.

★ ★ ★

PANEL DISCUSSION on Influence of Non-ferrous Metals and Their Compounds on Corrosion of Pressure Vessels, a symposium, presented at the Fifty-first Annual Meeting of The American Society for Testing Materials, has recently been published in a 45 page booklet which can be procured from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. at $1.00 each.

★ ★ ★

ELECTRIC POWER USE will expand for years, said C. E. Wilson, president of GE Co., recently. Utilities will install 6,700,000 kilowatts of generating capacity this year and had a record output of 282,000,000,000 kilowatt-hours in 1948. More than three-fourths of these power needs are supplied by steam-turbine generators. In our opinion, that ratio will probably hold for a long time in the stationary power field, or approximately so. If that turns out to be the case, the importance of the steam plant in our overall power engineering field is obvious.

HERE IS AN oil to coal conversion of a type we haven't seen for some time. The ship Oakey L. Alexander of the Pocahontas Steamship Company's coal-carrying fleet, has been converted from an oil burning to a coal burning vessel. Formerly the Laconia Victory, the collier was converted to coal burning by the Newport News Shipbuilding and Dry Dock Company and is claimed to be the largest and fastest collier on the Atlantic Coast.

★ ★ ★

LARGE-SCALE movement of German military and civilian elements to underground installations, in an attempt to minimize the effectiveness of allied air power, became a very important phase of the overall German war activity in World War II. It materially effected the course of the war and, with more adequate advanced planning by the Germans could have caused a prolongation of their ability to wage war effectively. Among the German underground installations many were heated and ventilated. The technical details of how this was done are presented in a most interesting and valuable article in the *Journal of the Institution of Heating and Ventilating Engineers* of Great Britain, February 1949 issue.

These engineering details are presented by L. C. C. Rayner with discussion by many leading British engineers. Following the discussion, the author concluded, from summarizing all the information, that in installations of this type the Americans believed that if everything was done automatically so much the better. The Germans held that the cheaper the installation and the less material used and the fewer gadgets to go wrong, the better. The English took the middle course, and the author hesitated to say whether that was best but was the one that had been followed in that country for a good many years.

Naturally we hope that in the United States we shall not have to install many underground installations, although the public may rest assured that full consideration has been given to their value. Many competent observers reject the idea as impractical and psychologically bad. A great deal of work was done during the war in certain installations, which we are not permitted to discuss, and the engineering problems, particularly those of power supply and heating and ventilation, are extremely interesting. But if enough people in the world are convinced that the human race has a higher destiny than to burrow into the ground like moles to keep from killing itself off, then the whole discussion may become academic.

★ ★ ★

POWER ENGINEERS, concerned every day with horses and their power (horsepower in the turbine changed into kilowatt hours in the generator), should be interested in this one. Horses, the animal kind, still lead tractors on our nation's farms by 3-to-1. The ratio was 40-to-1 in 1925. According to the Deparment of Agriculture's data, the tractors are gaining but the horses are still pretty far ahead.

★ ★ ★

ALTHOUGH it was designed primarily to indicate poisonous mercury-vapor concentrations, GE's instantaneous electronic mercury-vapor detector can whiff and report such vapors as ozone, illuminating gas, benzene and pyridine. We have never seen the detector used for the latter purposes although we have seen it installed at the mercury-vapor power plant at Hartford; but do not know how often it has needed to operate there. Seldom, we assume—and hope.

Mexico City's Giant New Diesel-Electric Plant Lubricated 100% with Texaco

Mexican Light and Power Company, Ltd., lubricates battery of "hemisphere's biggest" Diesel engines with Texaco Ursa Oils.

TEXACO congratulates the Cía. Mexicana Meridional de Fuerza S. A., subsidiary of the Mexican Light and Power Company, Ltd., on its completion of one of the biggest Diesel engine installations in the world. The six Nordberg 12-cylinder 8650 bhp. engines employed are the most powerful single-acting, two-cycle Diesels ever built in the Western Hemisphere.

Texaco Ursa Oils were chosen to lubricate these Diesels because they keep engines clean . . . rings free . . . ports open . . . resist oxidation and stand up under heat and pressure. That, in fact, is why—

More stationary Diesel hp. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.

Texaco Ursa Oils are approved by leading Diesel engine manufacturers. Use them to reduce your Diesel maintenance costs and fuel consumption. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write: The Texas Company, 135 E. 42nd St., New York 17, N.Y.

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FOR ALL DIESEL ENGINES

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YARWAY now offers a COMPLETE SYSTEM for constant, accurate check

Yarway Remote Liquid Level Indicator, operated by the pressure differential between a constant head and the varying head in the boiler drum. Never under pressure. No stuffing boxes.

YARWAY

YOUR BOILER WATER LEVEL?

Dependable, constant indication of boiler water and other liquid levels is now available with a complete Yarway system.

At the boiler drum—Yarway offers the well-known Hi-Lo Alarm Water Column with tubular or pressure-sealed Flat Glass gages with "floating assembly" that reduces leakage and glass breakage.

On the instrument panel—Yarway's Remote Liquid Level Indicator, operated by the boiler water itself, gives instant, accurate indication at eye level. Or the Yarway HI-LO-GRAPH Recorder gives both indication and round-the-clock recording of the water level.

Throughout the plant—at any desired locations, Yarway Remote Signal Alarms (lights or horns) operated by a Control Unit on the Yarway Indicator, or Recorder, give additional checks on boiler water levels.

Why not let a Yarway Engineer show you how this Yarway System can increase the efficiency and safety of your power plant operation?

For complete information on Yarway Indicators ask for Bulletin WG-1822.

YARNALL-WARING COMPANY
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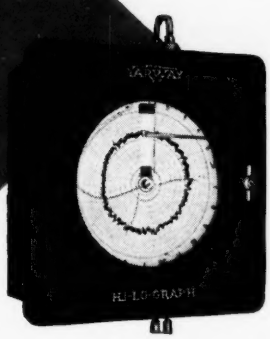
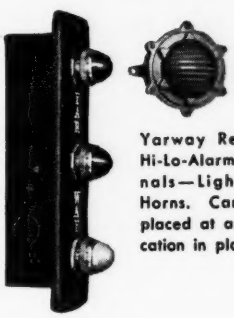
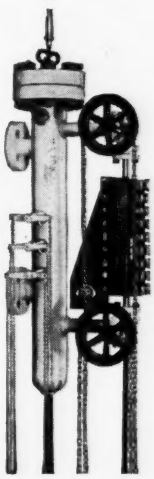


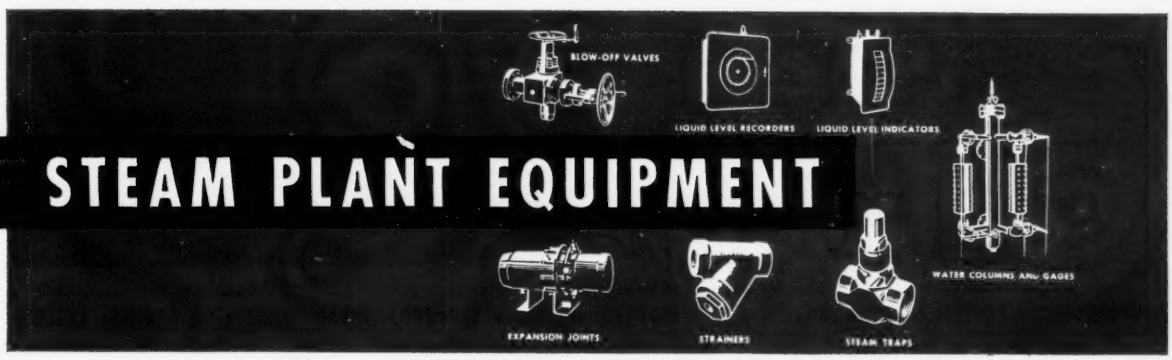
Yarway HI-LO-GRAPH Recorder provides not only water level indication but a 24-hour recording of water levels. See Bulletin WG-1830.



Yarway Remote Hi-Lo-Alarm Signals—Lights or Horns. Can be placed at any location in plant.



Yarway Floatless Hi-Lo Alarm Water Column with Vertical Flat Glass Gages with "Floating Assembly." See Bulletin WG-1811

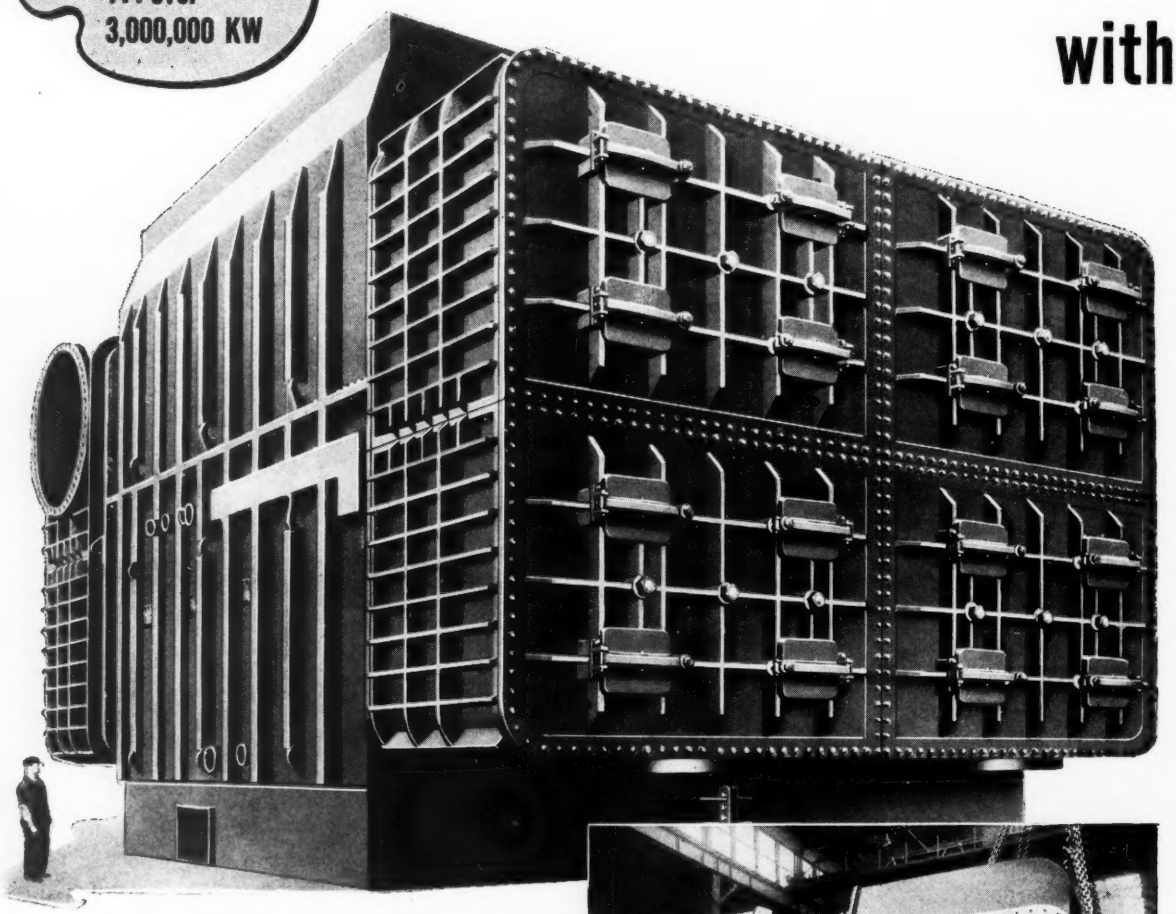


Two Reasons Why

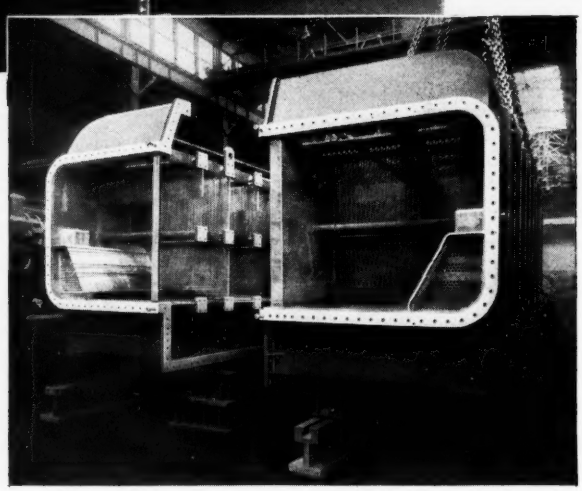
YOU SAVE SPACE

with

I-R Rectangular Design ... over 3,000,000 KW



(Above) This giant 90,000 sq ft condenser will serve a 150,000 kw turbo-generator. The compactness of the I-R design made it possible to fit the cube-shaped space available.



(Right) Factory assembly of a 32,500 sq ft condenser. Notice the full flanged joints and bolting pads of the internal bracing, which eliminate field-fitting and welding.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

and ERECTION COSTS

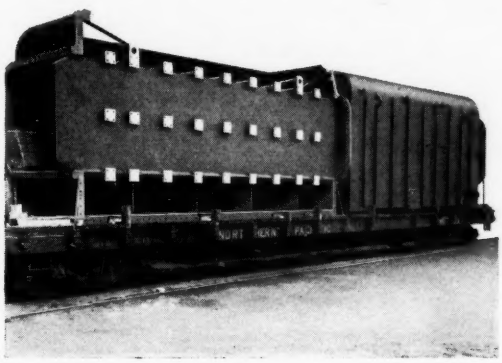
I-R Rectangular Condensers

(1) RECTANGULAR DESIGN to fit a rectangular space

BACKED BY OVER 3,000,000 KW. Post-war installations and orders for Ingersoll-Rand condensers of *rectangular design* to serve over 3,000,000 kw of turbo-generators prove that utilities are taking advantage of the savings in this compact, high efficiency condenser. I-R Rectangular Condensers, built with liberal design proportions, make the most efficient use of the rectangular space available under the turbine foundations.

Twenty-seven years ago Ingersoll-Rand broke with tradition in setting a new standard in heat-transfer efficiency which greatly reduced the amount of surface and physical size of a condenser required for a given capacity. This I-R pioneered design provided positive control of the steam flow through a low-friction-loss tube nest, thereby eliminating "drone" surface and causing all the tubes to work at a maximum condensing rate.

For years these features were built in the famous "Heart Shape" shell. Today to meet the even more stringent space requirements *Ingersoll-Rand has again led the field* by successfully incorporating these time-proven features in a still more compact rectangular shell.



A condenser, now in sections, on its way to the customer's plant. When erected all parts lined-up perfectly and there was a minimum of field welding. No field welding is necessary on I-R condensers being built today.

(2) Complete FACTORY ASSEMBLY and FLANGED CONSTRUCTION to eliminate field-fitting and welding

Every I-R condenser is completely assembled and hydrostatically tested in the factory. On units that are too large to ship in one piece, all mating surfaces of each section are machine-flanged, aligned, and dowelled. All internal bracing which must be split for shipment is also machine-flanged.

Thus when these sections arrive at the customer's plant they are easily bolted together with no field-fitting necessary. No erection welding is required in the field. "Flanged Construction" is an I-R tradition . . . in use since 1922.

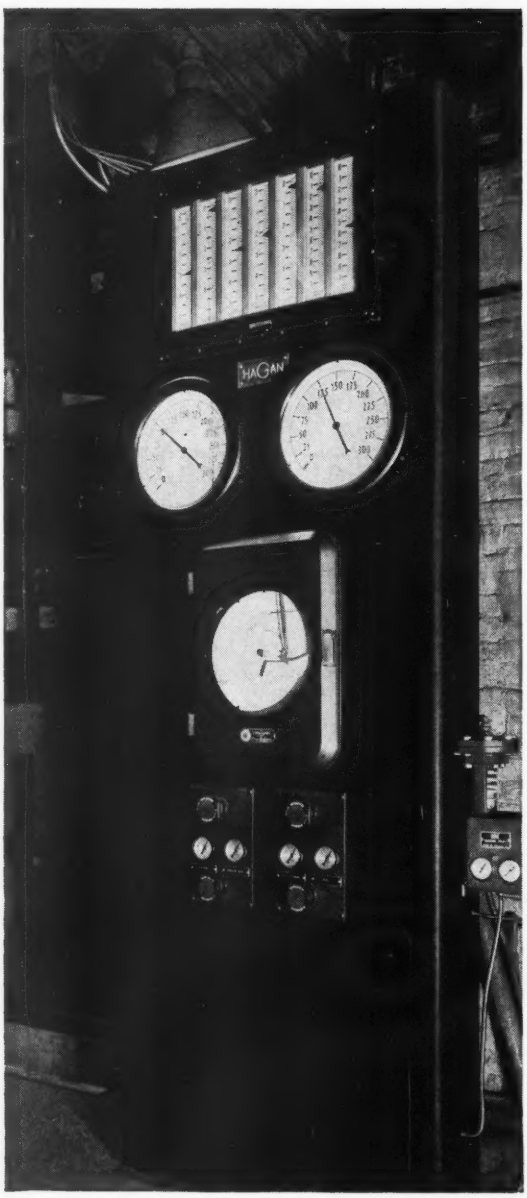
These and other exclusive features of Ingersoll-Rand Surface Condensers combine to save you money.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 435-4

Boiler room modernization includes

HAGAN controls at WAYNE WORKS



Wayne Works, Richmond, Indiana, is an important manufacturer of school bus bodies and other motor coach bodies of special types.

Steam use in this plant is primarily for the heating of approximately 463,000 square feet of floor space in the various buildings, although a certain amount of process steam is required. Total demand ranges from a minimum of 10,000 lb./hr. to a maximum of 60,000 lb./hr.

To meet increased demand, and also to provide greater economy in steam production, the company has started modernization of the boiler plant. The first step in this moderniza-

Hagan Control Panel with Hagan Ring Balance Boiler Meter. Panel is located between new and old sections of boiler room.

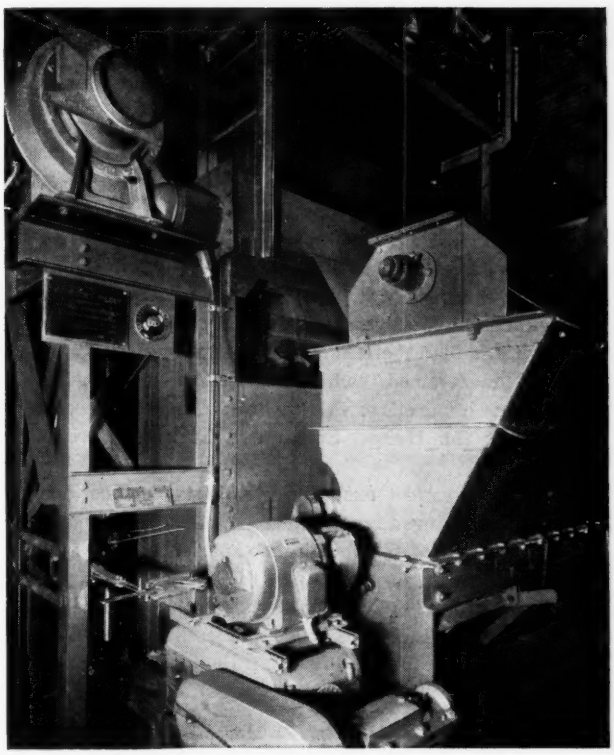
s and meters

tion was the installation of a 100 psi, 30,000 lb./hr. chain-grate fired boiler, equipped with Hagan Automatic Combustion Control and Hagan Ring Balance Boiler Meter.

The meter is of the two-pen type, providing a chart record of steam flow and air flow. Steam flow is also shown on a strip indicator.

Since the older boilers which are still in service are manually operated, the advantages of the trouble-free, fully automatic operation of the Hagan system are keenly appreciated by the boiler operators.

For full information on Hagan Controls and Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



View of boiler, taken from in front of control panel. Installation was made by Oberle-Jordre Co., of Richmond. William H. Junker of Wm. W. Carleton and Associates, Cincinnati, was consulting engineer. W. H. Treffinger, Plant Engineer of Wayne Works, was in charge of the project.

Bus Bodies like these represent the greater part of Wayne Works production, but special bodies of many types are also manufactured.

HAGAN HALL BUROMIN CALGON

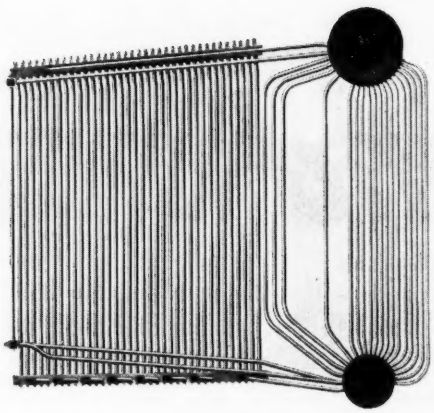
HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

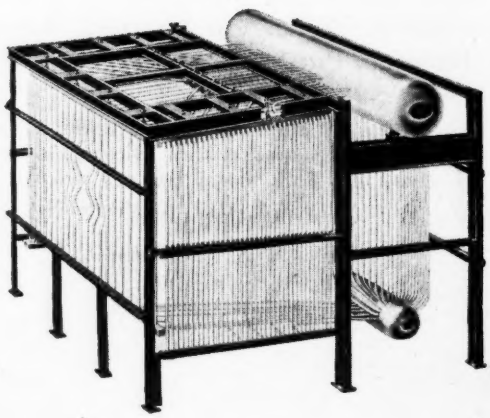
6 FEATURES of the VU Steam Generator that assure low-cost steam for medium and smaller plants

The structural features illustrated and described on these pages are to a large degree responsible for the efficient combustion, consistent production of dry steam at all ratings, high thermal efficiency, trouble-free operation and low steam costs which characterize the operation of the many hundreds of VU Steam Generators in service throughout the United States and in many foreign countries.

Designed to meet exacting, big-plant specifications, the VU Unit brings to medium-sized and smaller plants the advantages of Combustion's experience with high capacity, high pressure units, plus the obvious benefits of standardization. The VU Unit is virtually universal in application. It is available in capacities from 20,000 to 350,000 lb of steam per hr. It can be adapted to meet widely varying conditions of load, pressure and temperature. It can be fired with coal, oil, gas or any combination of these fuels. Compare its features item by item with those of any similar equipment on the market. They explain why the VU Steam Generator is so widely regarded as the finest equipment available for any steam requirements to which it is applicable. B-321



Symmetrical Design. Any section taken through the unit from the front to rear is similar to any other section so taken. Each elemental section includes the same amount of furnace volume, the same amount of boiler heating surface and the same amount of superheater surface as any other. The volume of gases, their velocity and temperature, at any point from front to rear, are practically constant across the width of the unit.



Overhead Suspension. Complete freedom of expansion in all directions is provided by suspension of all parts of the unit from the steel structure which provides the framework for the outer steel casing. This feature makes ample provision for the effects of temperature changes; it eliminates abnormal mechanical stresses on all pressure parts and explains to a large degree the freedom of the VU Unit from leaky joints.

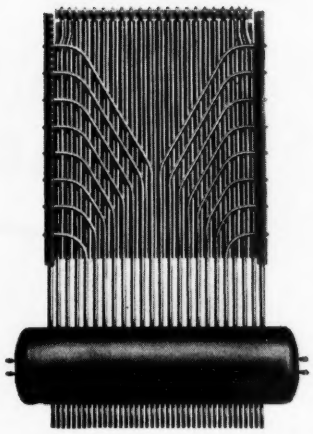
C-E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

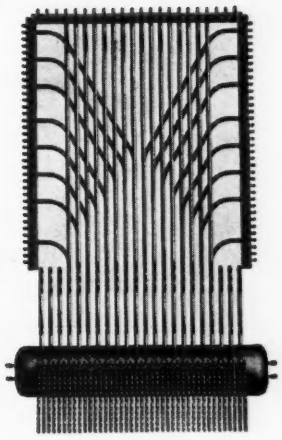
A Merger of Combustion Engineering Co., Inc. and The Superheater Co.

200 Madison Avenue · New York 16, N. Y.

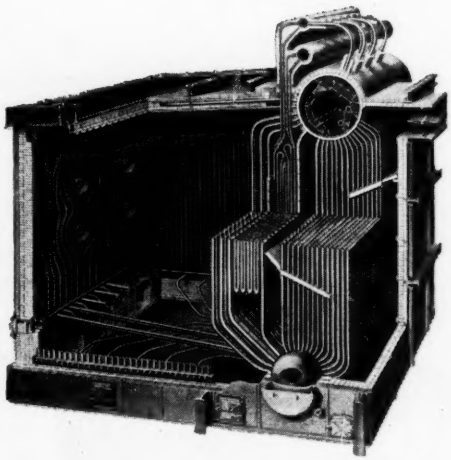
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



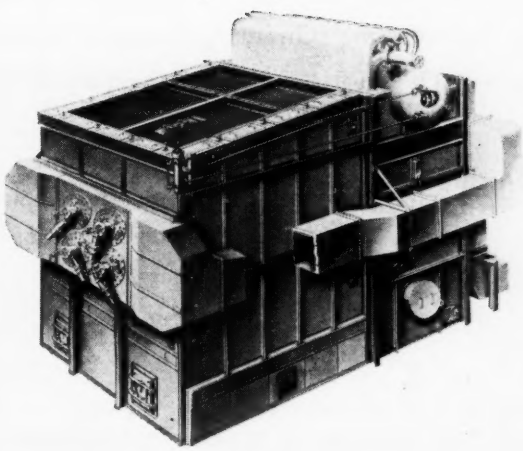
Quality Steam. All of the most active steam producing tubes enter a baffled area in the drum which discharges well above the normal water line and uniformly across the full length of the drum. This arrangement reduces turbulence to a minimum and permits effective utilization of the entire steam release space. Dry steam and a stabilized water level are thus assured even under adverse conditions.



Standardized Construction. Painstaking refinement of detail is incorporated in each unit at a small fraction of the original engineering cost. With standard parts and structural features the merits of which are confirmed by experience, manufacturing and erection costs are materially reduced. First cost reflects the economies of standardization and the buyer benefits even before the VU Unit is placed in operation.



Adaptable In Application. The VU Unit can be adapted, without sacrifice of the benefits of standardization, to a great variety of conditions: where space limitations are imposed; to burn coal, oil, gas or any combination of these fuels; to meet widely varying requirements of load, pressure and temperature. Inclusion of inter-bank or inter-tube superheater or an air heater is easily accomplished as conditions require.



Steel Encased Setting. The unit setting of shaped tile, refractory and 100% insulation are attractively finished by a permanent outer steel casing. This design, evolved from careful study and experiment, reduces to a minimum heat losses caused by radiation and air infiltration. It tends to eliminate hot spots and helps maintain a uniformly low surface temperature throughout the steel casing. Maintenance is negligible.

DETROIT PUBLIC LIBRARY

MY SERVICES COST MUCH LESS THAN 'DOWN' TIME

"I am De Laval Centrifugal Force. I protect turbines and engines against troubles caused by impure oil—and the cost of my services, both the original cost and the operating cost, is so much less than the cost of even ***one*** serious shutdown that I am in effect inexpensive insurance.

"As used in a De Laval Oil Purifier, I instantaneously remove from lubricating oil all water, dirt or sludge, thus keeping the oil clean and making it safe to use over and over again.

"I can also be used to good advantage in connection with the De Laval-Funk Process, which minimizes the formation of sludge within the lubricating system. On many types of turbine oils, the De Laval-Funk Process is the ultimate in protection.

"I am available in a wide range of capacities, enabling every power plant operator to secure the correct unit for his need."

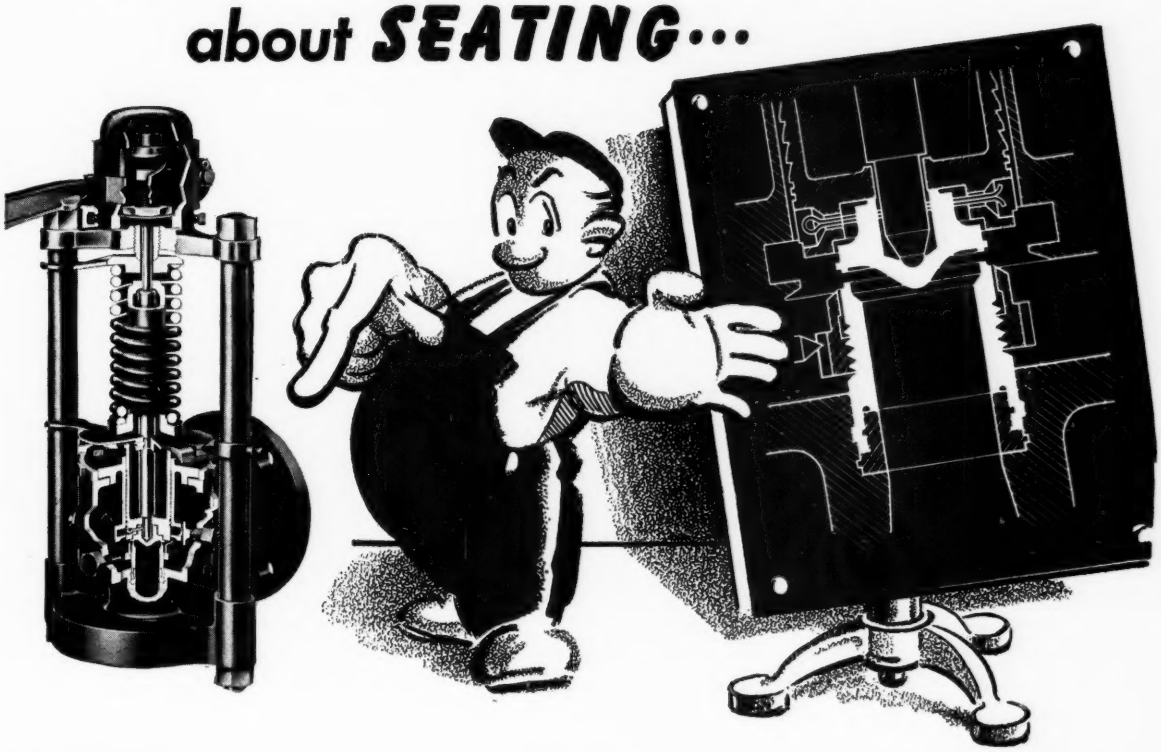
● ***Write for Bulletin TO-1.***

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

De Laval OIL PURIFIERS

We Studied SAFETY VALVE LEAKAGE

— Here's what we found out about SEATING...



We found — what most power plant men already know...that in order to be tight, a safety valve must have matched, wear resistant, corrosion resistant seating surfaces, and that the disc must seat square.

We found — what power plant men have long suspected...that uneven expansion, causing dragging of one seating surface over the other, can destroy the seat so completely that the safety valve has to be overhauled or replaced, even though it has never been popped.

We found ...that when nozzle and disc are made of alloys with the same coefficient of expansion, and with sections designed so that their rate of heat absorption is the same, destructive drag is eliminated. This is one of the basic features of the Gentzel Design, and is the reason Foster 38-SV Safety Valves can be guaranteed to stay tight.

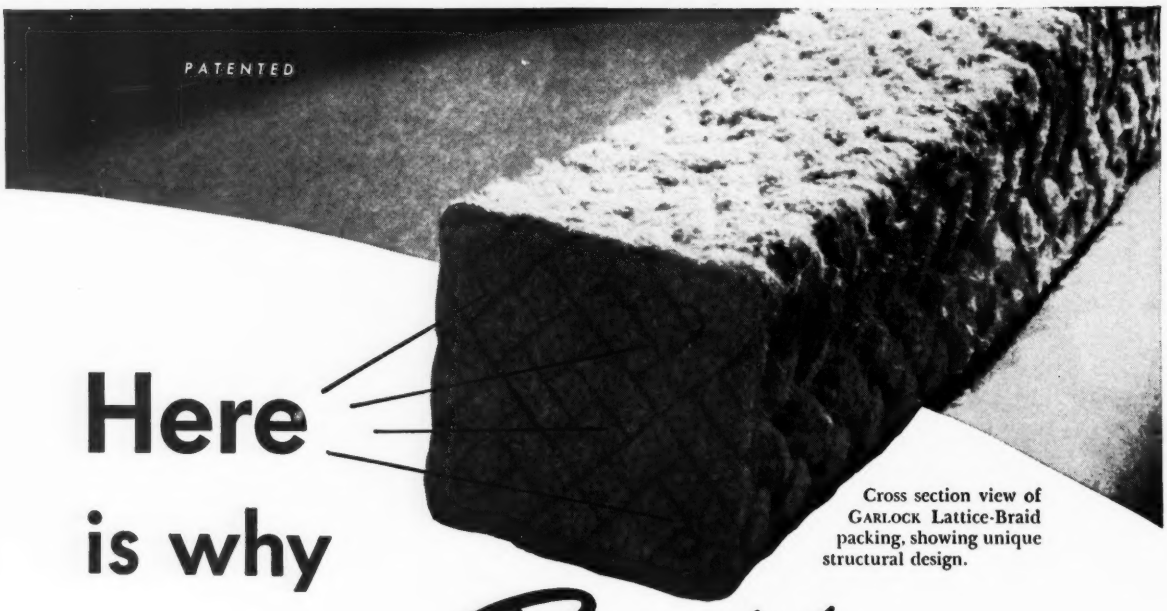
To you ...this means elimination of costly boiler outage due to safety valve leakage. Other guaranteed *and proven* advantages are...consistently accurate popping ...minimum blow-down, which can be held to as little as 1%...highest relief capacity for a given nominal valve size...and extremely low maintenance.

For full details on the design and construction features that enable this valve to outperform ANY other safety valve, get in touch with your Foster Representative or with us direct.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

835 LEHIGH AVENUE • UNION, N. J.



Cross section view of GARLOCK Lattice-Braid packing, showing unique structural design.

Here is why

Lattice-Braid Lasts Longer

ASBESTOS

GARLOCK 730—for hot or cold water at medium to high pressures.

GARLOCK 731—for steam, gases or water at temperatures up to 700° F.

GARLOCK 732 (wire inserted)—for heavy duty service against steam, oil, gases or water at temperatures up to 700° F.

GARLOCK 733—for hot or cold water or alcohol at medium or low pressures.

GARLOCK 734—for cold gasoline, kerosene and light oils.

GARLOCK 736 (blue asbestos)—for concentrated mineral acids.

FLAX

GARLOCK 740—for cold water at medium or low pressures.

GARLOCK 745—for heavy hydraulic service against cold water.

COTTON

GARLOCK 751—for hot or cold water.

The individual strands are braided *through and through* in an entirely different way by specially built braiding machines designed exclusively for manufacturing Garlock Lattice-Braid packing.

All braided strands are strongly lattice-linked together into a structural unit which holds together even when the packing is worn far beyond the serviceable limits of wear of ordinary braided packings.

The unique structural design of Garlock Lattice-Braid packing also provides unusual flexibility and built-in controlled porosity which imparts semi-automatic action and keeps the packing properly adjusted in the stuffing box.

Write for folder!

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK *Lattice-Braid* PACKING

RAPID REACTORS

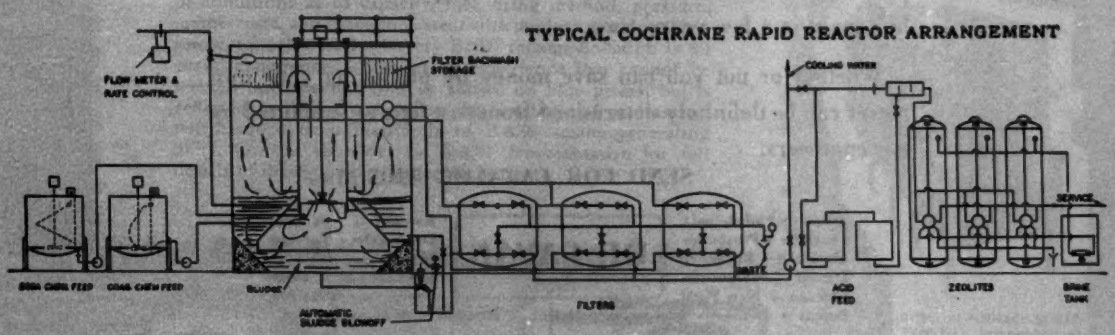
COMBINING the basic elements of equipment for mixing, floc formation, settling, and thickening in a single reaction vessel, the Cochrane Rapid Reactor is finding widespread application in industry for the conditioning of process cooling water and boiler feed. Chemical reagents may be introduced for coagulation of turbidity alone, for partial softening with coincident turbidity reduction, or for complete softening and turbidity reduction. The choice of reagents will be governed by the characteristics of the raw water and the purpose for which the treated water is to be used.

By its improved design, the Cochrane Rapid Reactor permits chemical reactions and separation of coagulated solids in only a fraction of the time necessary in intermittent cold process softeners. The retention time in a Cochrane Rapid Reactor will depend upon conditions, but usually is of the order of 60 to 70 minutes, as compared to four hours or more with conventional cold process softeners or clarification systems.

This improvement is attained by scientific application of an old principle of sludge recirculation in which the sedimentation tank is so arranged with forced pumping of the sludge that when the chemicals are added to the incoming water they react in the presence of large quantities of sludge; the sludge seeds the precipitation and accelerates the chemical reactions. In addition to the acceleration of the chemical reactions the initial precipitate, which is colloidal in nature, is rapidly coagulated and separated from the water. From this fact the device derives its name "Rapid Reactor."

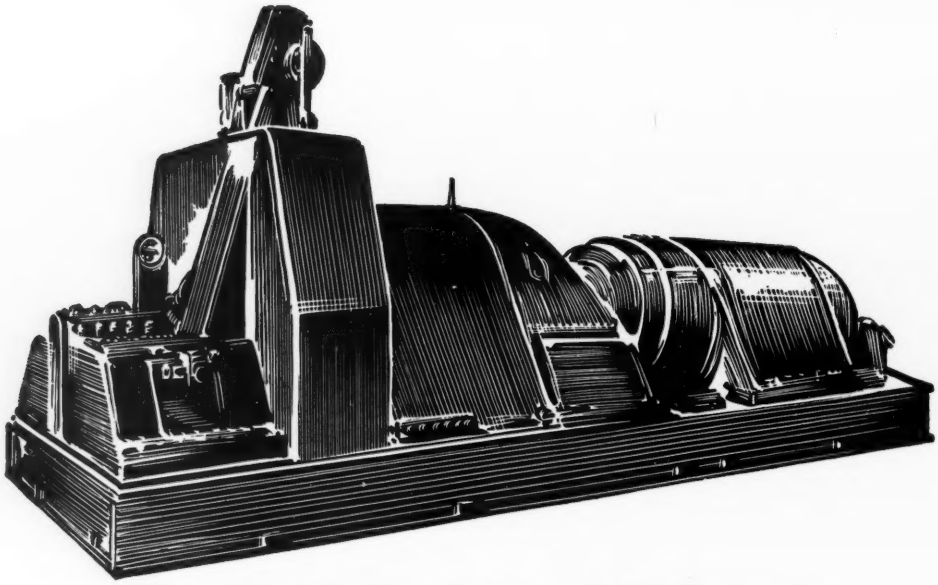
Write for a copy of Publication No. 4425

TYPICAL COCHRANE RAPID REACTOR ARRANGEMENT



COCHRANE

COCHRANE CORPORATION • 3123 N. 17th Street • PHILADELPHIA 32, PENNA.



POWER IS CHEAP

WHEN PRODUCED AS A BY-PRODUCT

Wherever steam also is required in appreciable quantities for heating or processing, power can be produced at surprisingly low cost with a turbine designed for extraction or back pressure service. Often the cost of the small amount additional fuel required to produce power is so low that the entire equipment investment can be repaid in a few years' time.

Whether or not you can save money by producing your own power can be definitely determined from cost figures submitted by our engineers.

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DE LAVAL

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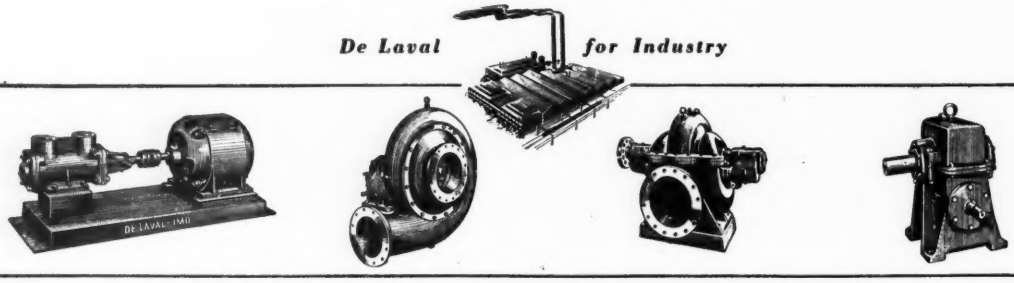
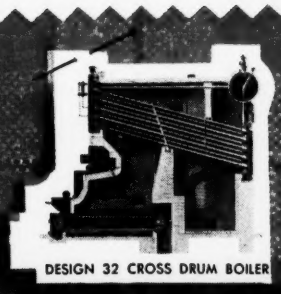
De Laval *for Industry*

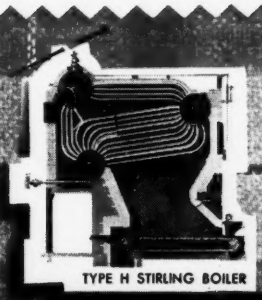


DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, N. J.

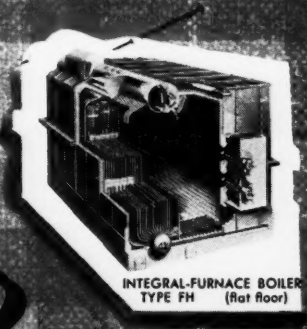
TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS



DESIGN 32 CROSS DRUM BOILER



TYPE H STIRLING BOILER



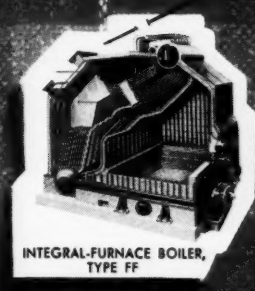
INTEGRAL-FURNACE BOILER
TYPE FH (flat floor)

Popular Patterns

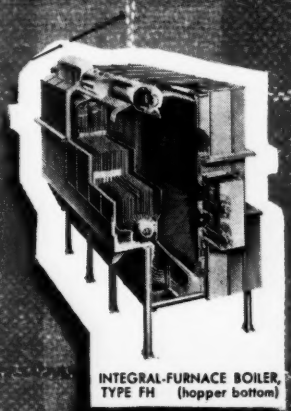
FOR LOW-COST STEAM

These styles in steam designed by B&W are strong favorites among industries and power companies year after year. Many architects, consulting engineers and contractors, too, turn to B&W first when fitting steam generating equipment to non-industrial requirements from airports to zoos. They all know from long, satisfactory experience that B&W boilers are soundly designed, built and applied to fulfill the specific requirements of each job... that they are the last word in dependable, low-cost steam generation for any combination of conditions as to capacity, fuel, firing method, pressure, temperature, and space consistent with modern practice. They know, too, that back of every B&W recommendation is 80 years' experience... cost-saving experience that cannot be written into specifications or shown on blue prints, but is reflected in the year-after-year dependable and economical performance from thousands of B&W steam generating units. Consult your nearest B&W representative for full details of these popular boiler designs.

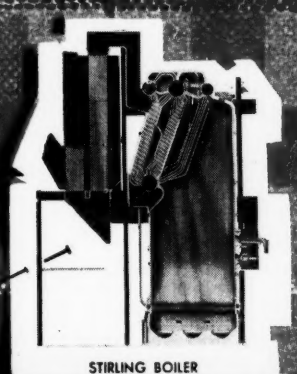
G-437



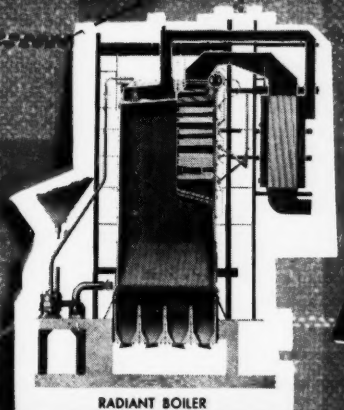
INTEGRAL-FURNACE BOILER,
TYPE FF



INTEGRAL-FURNACE BOILER,
TYPE FH (hopper bottom)



STIRLING BOILER



RADIANT BOILER

B&W

BABCOCK & WILCOX

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

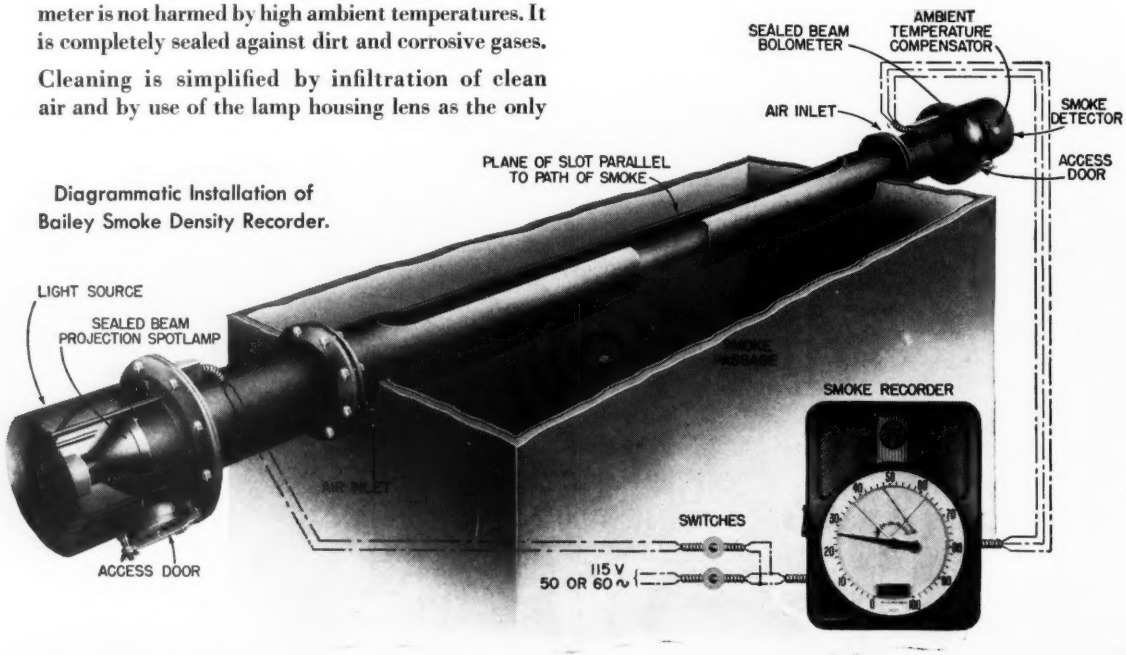
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1040 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil in a Midwest utility.

Turbine ..... 35,000 KW, 1800 RPM
Oil System Capacity .... 2800 gallons
Operation ... 1931 to 1937 on Turbine Oil X at 45¢ per gallon
Operation ... 1938 to 1948 on Nonpareil Turbine Oil at 87¢ per gallon
Annual Cost of Lubrication with Turbine Oil X $911.57*
Annual Cost of Lubrication with Nonpareil Turbine Oil ... $284.13*
Annual Saving ... 68.8%

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil on a large utility turbine.

Turbine ..... 80,000 KW, 1800 RPM
Oil System Capacity .... 8,000 gallons
Operation ... Dec. 1935 to April 1942, on Turbine Oil Y at 39¢ per gallon
Operation ... May 1942 to Jan. 1948 on Nonpareil Turbine Oil at 88¢ per gallon
Annual Cost of Turbine Lubrication with Turbine Oil Y $575.30*
Annual Cost of Lubrication with Nonpareil Turbine Oil $503.93*
Annual Saving 12.4%

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil in a Midwest utility system.

Turbine ..... 20,000 KW (Now 30 years old)
Oil System Capacity .... 550 gallons
Operation ... June 1940, to Aug. 1944, on Turbine Oil Z at 55¢ per gallon
Operation ... Oct. 1944 to Oct. 1948 on Nonpareil Turbine Oil at 89½¢ per gallon
Annual Cost of Lubrication with Turbine Oil Z $83.90*
Annual Cost of Lubrication with Nonpareil Turbine Oil $69.49*
Annual Saving 17.2%

* Includes (1) cost of original fill—including interest charges, (2) oil replacements, (3) oil treating or sweetening, (4) cleaning turbine oil systems, (5) filter maintenance (where these items apply).

Turbine lubrication costs CUT... up to 68%

STUDIES have been made of typical utility company operations to determine how much the *price* of turbine oil affects the *cost* of turbine operation. Three such studies are summarized here. In each case, the price of the original fill of oil was 38% to 55% *less* than that for Nonpareil. But in each case the total annual cost for lubrication, when all factors are considered, shows a saving with Nonpareil.

You can find out how much Nonpareil will save on your lubricating costs. Standard Oil Lubrication Engineers have facts and figures to help you determine costs of Nonpareil lubrication for comparison with your present costs.

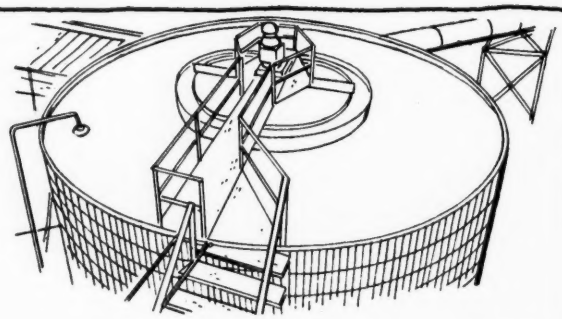
Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, to secure the services of the Engineer nearest you.

NONPAREIL
Turbine Oil
"WILL OUTLAST YOUR TURBINE"

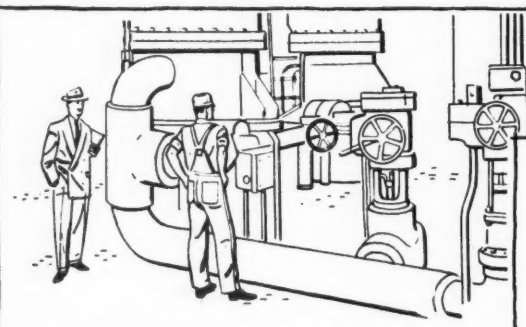
STANDARD OIL COMPANY (INDIANA) STANDARD

YOU GET Complete Recommendations IN HALL BOILER WATER CONDITIONING

When Hall engineers have studied your plant, they recommend procedures which cover not only treatment of boiler water, but also all points of the water and steam cycle which affect the maintenance of desired conditions.

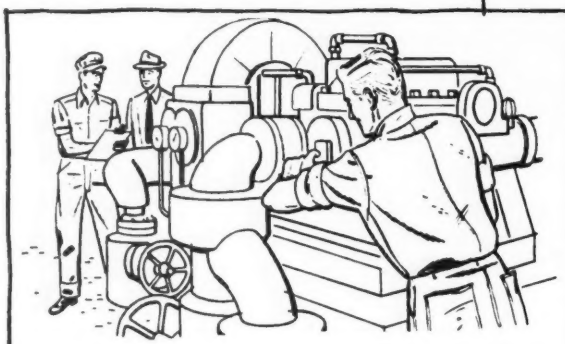


1. Where softening, clarifying or other pretreatment of raw water is advisable, Hall recommends types of equipment, advises as to results which can be expected with various types of equipment, and shows how to use new or existing equipment to best advantage.



2. Hall recommendations include procedures for the prevention of deposition in pre-boiler equipment, such as feed water heaters, valves, regulators, etc.

3. Water conditions which must be maintained within the boiler are prescribed; testing procedures for checking these conditions are set up; and detailed instructions for maintaining these conditions are given.



4. Steam-using equipment, condensing equipment and condensate return lines may present difficulties, and procedures for preventing these difficulties are part of Hall recommendations.

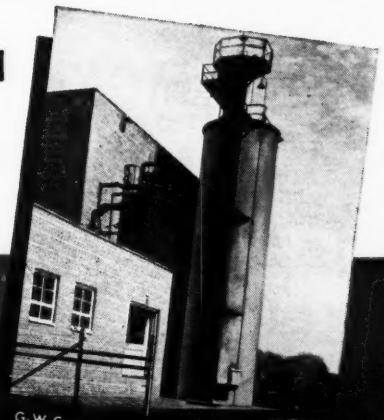
Hall Laboratories believes that its work can be summed up in a single phrase—*to do whatever is necessary to help you keep equipment operating effectively.* The best evidence of the value of Hall Service in accomplishing this is the hundreds of plants, large and small, who use Hall Service year after year. Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

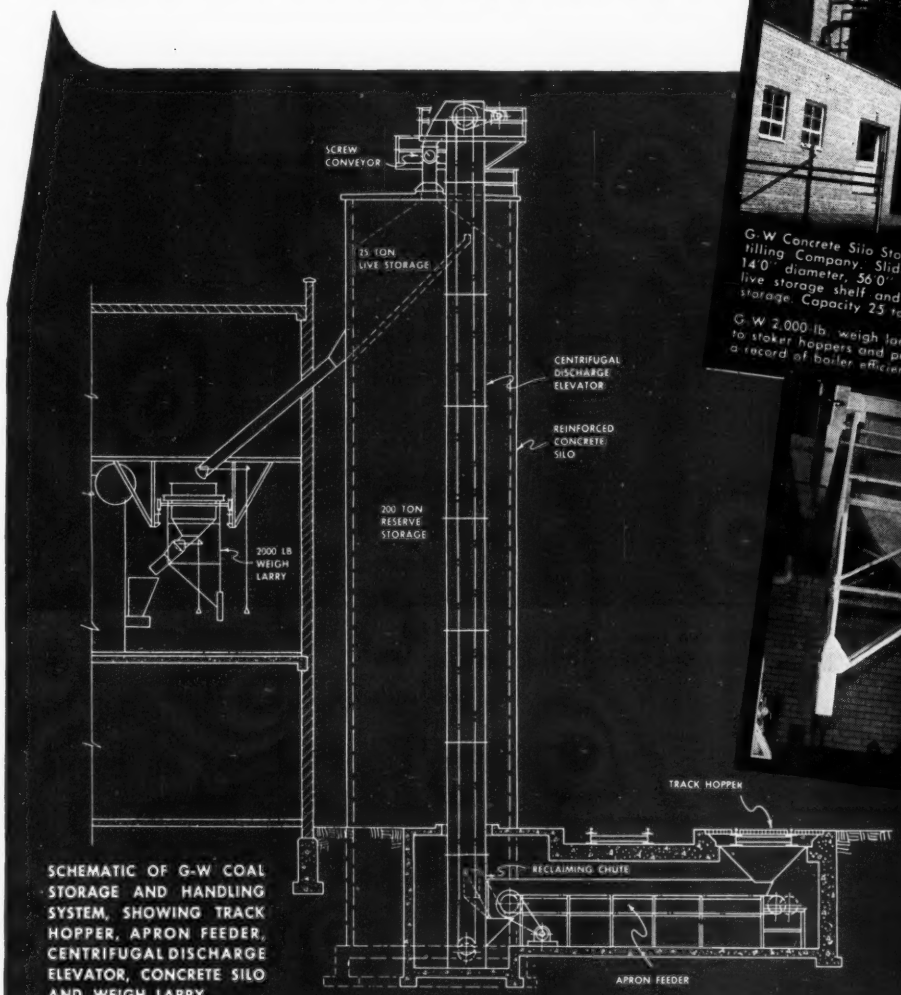
CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

Your Cost of HANDLING Coal Depends On How You STORE It



G-W Concrete Silo Storage System at Clinton Distilling Company. Sliding form construction. Silo 14'0" diameter, 56'0" high. Designed with 25-ton live storage shelf and 200-ton available reserve storage. Capacity 25 tons hour.

G-W 2,000-lb. weigh larry at Clinton delivers coal to stoker hoppers and provides means for keeping a record of boiler efficiency.



SCHEMATIC OF G-W COAL STORAGE AND HANDLING SYSTEM, SHOWING TRACK HOPPER, APRON FEEDER, CENTRIFUGAL DISCHARGE ELEVATOR, CONCRETE SILO AND WEIGH LARRY.

The problems of automatic coal and ash handling in steam generating plants fall into the general design pattern of one of four basic types of G-W coal storage systems.

The system illustrated is an example of this kind of simplified engineering. Conditions at Clinton Distilling Co., Clinton, Iowa, called for the reinforced concrete type silo as best suited to their location, available space, and allowable initial cost per ton of storage. To complete the installation, G-W installed track hopper, apron feeder, centrifugal discharge elevator, and a 2,000-lb. weigh larry.

One of the four basic G-W Storage Systems with proper handling equipment, will be the right one for *your* plant conditions—Concrete Silo, Vitrified Tile Silo, Cylindrical Steel Tank, or Suspended Steel Bunker. Every complete G-W Coal and Ash Handling System is fabricated and installed under *one* contract, *one* responsibility, *one* delivery schedule.

Gifford-Wood's 135 years of materials handling experience is available without obligation to consultants, engineers and plant owners. If coal and ash handling is your problem, get in touch with G-W today.

3517

GIFFORD-WOOD CO.

SINCE 1814

G-W HANDLES IT... faster • easier • cheaper

NEW YORK 17
420 LEXINGTON AVENUE

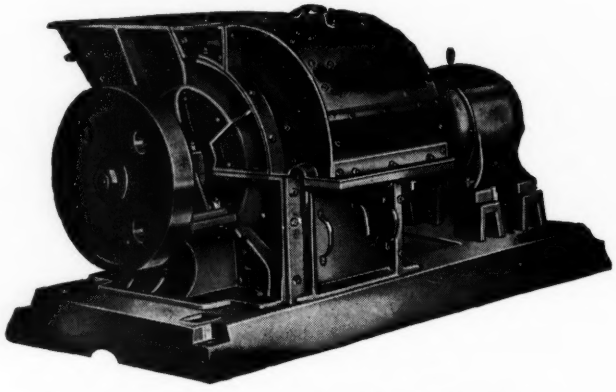
Factory:
Hudson, N. Y.

CHICAGO 6
565 W. WASHINGTON ST.

ASSURE MORE EFFICIENT *FIRING* THROUGH MORE EFFICIENT *PREPARATION* with AMERICAN CRUSHERS

Shown above is the preparation plant of the Windsor Power House Co., Power, W. Va., where the American Rolling Ring Crusher Model 42S (in insert) is in daily operation.

Quality of coal crushing is as important to combustion efficiency as the quality of coal itself—one reason why Americans are chosen by so many power plants to do the crushing job. The **splitting action** of Americans assures uniform sizing—no oversize—and fines are accurately controlled. The result: a dependable, constant yield of stoker or pulverizer size to assure a uniform, responsive firebed —for greater operating efficiency.



Designed especially for power plants, the American "S" Crusher is a compact, complete crushing operation which is installed in minimum headroom without extensive conversion —and with no auxiliary crushing facilities. Nine different sizes, with capacities from 25 to 500 TPH.

Write for bulletin on efficient coal preparation in power plants.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

PICTURE of a MAN who SAVED $34,000.00 for his Company

He changed to

RAINS *PACKING*

ON ALL COMPANY PUMPS

"Saved $34,000 by Avoiding Shutdowns"

Every time his company shut down for repacking, it lost $50 per minute for 3 hours. Production stopped. This had been necessary every 3 or 4 months until Rains Packing was installed. There hasn't been a shut down since.

"Saved on Cost of New Packing"

Rains Packing has saved his company from 50 percent to several hundred percent on purchase of new packing. It's difficult to believe . . . but it's a fact!

"Saved by Elimination of Costly Repairs"

One pump in particular had to have shaft sleeves replaced once every year. That doesn't happen any more. It never does with Rains.

"Saved by Increased Efficiency of Pumps"

After 30 days all pumps were tested for efficiency of operation and capacity. In many instances the percentage was increased at least 5 percent. Boy! That's just the same as savings!

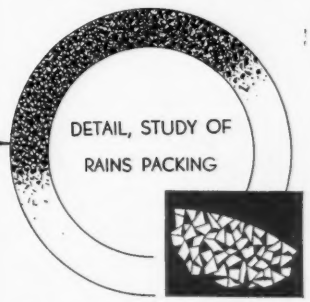
RAINS

WOOD•METAL PACKINGS

904 W. Broadway
Spokane, Washington, U. S. A.

1 LOW FRICTIONAL LOAD . . . the lubrication impregnated wood units act as reservoirs of lubrication throughout every fraction of a square inch of the packing. This creates osmotic action within the packing in operation causing a continuous seepage of lubrication on the rod or shaft forming an almost frictionless surface.

2 HIGH SEALING CAPACITY . . . is attained by the special angular shape of the wood and metal units, because they arrange themselves around the rod or shaft, forming a bearing-like wearing surface, completely leak-proof.



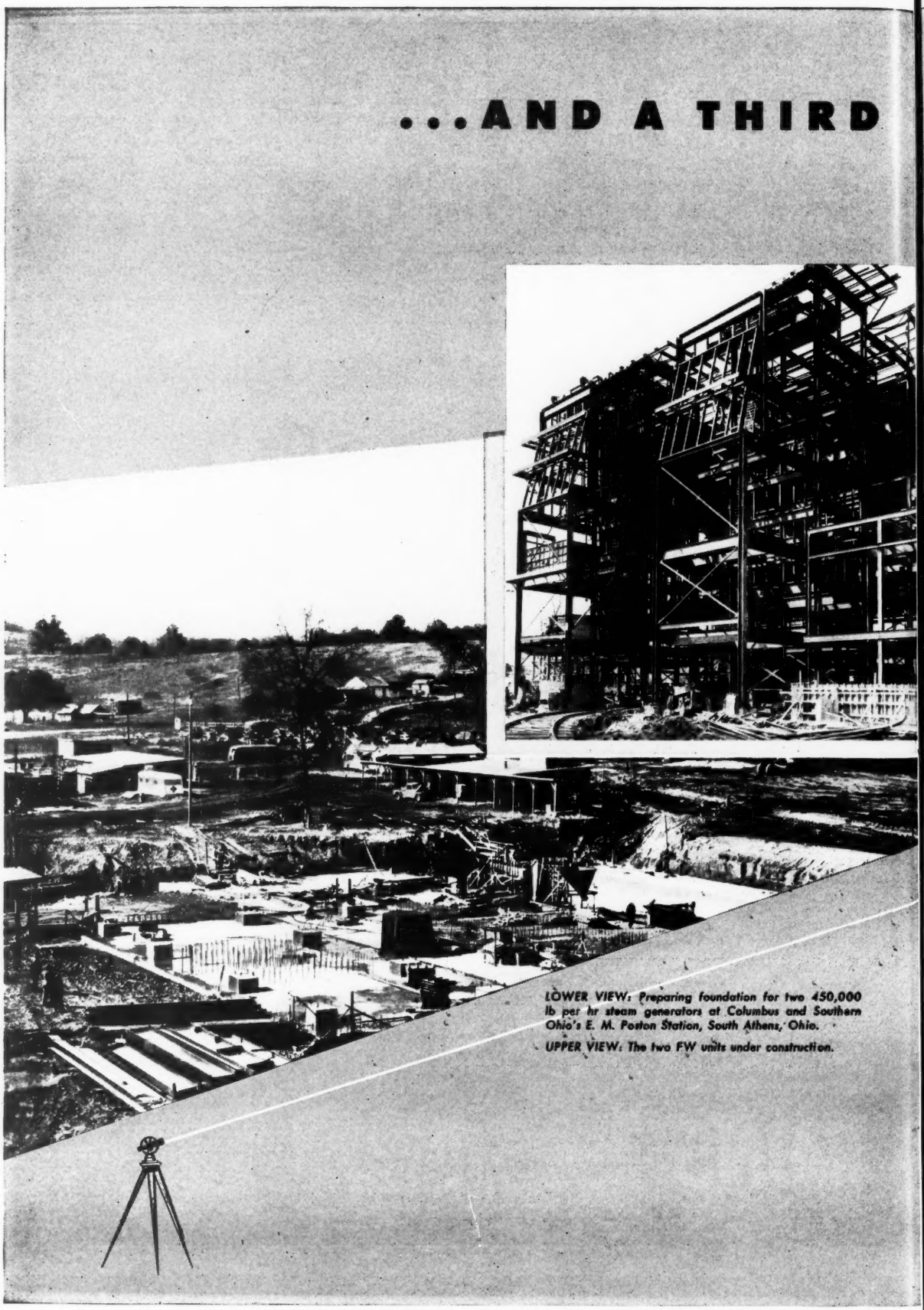
3 SAVES ROD AND SHAFT REPLACEMENTS . . . in all cases where Rains Wood-Metal Packing has been used, the original rods and shafts are still in operation and in a highly polished condition.

4 DURABILITY, ADAPTABILITY . . . Rains Packings reduce packing bills from 50% up to several 100%—and can be used on any piece of mechanical equipment having a standard stuffing box . . . on either rotating or reciprocating motion rods, stems or shafts—and on pressures to 10,000 lbs.

Proof on any type of pump furnished on request.

When ordering new equipment . . . Specify Rains Packing

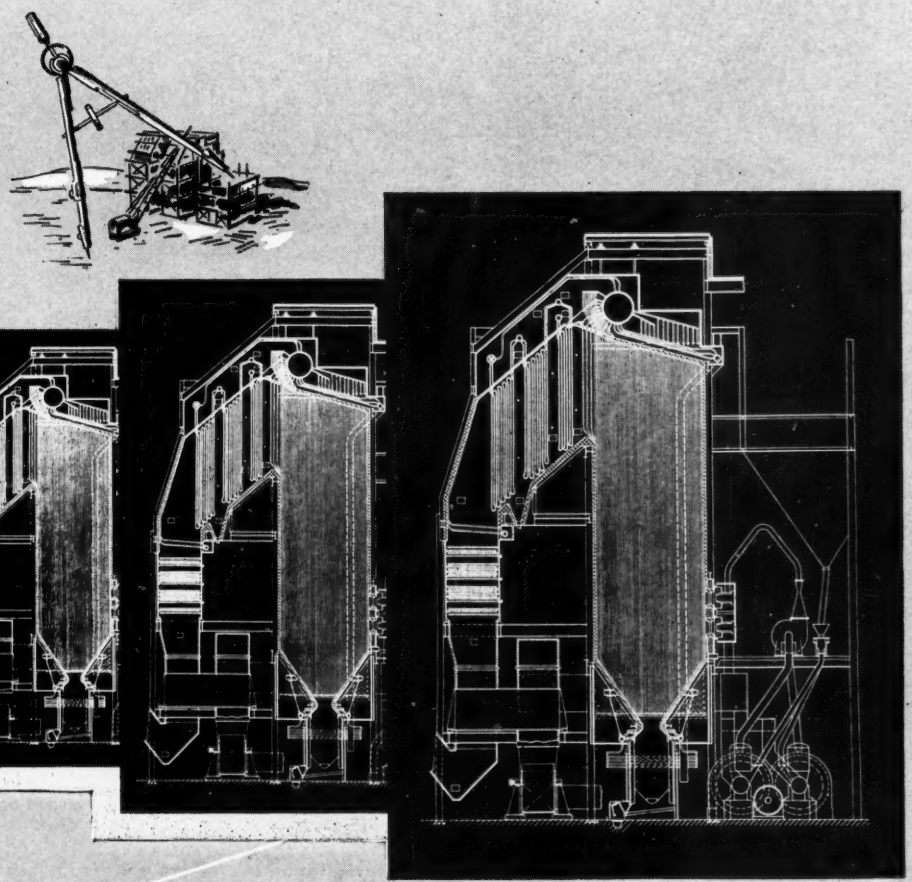
...AND A THIRD



LOWER VIEW: Preparing foundation for two 450,000 lb per hr steam generators at Columbus and Southern Ohio's E. M. Poston Station, South Athens, Ohio.

UPPER VIEW: The two FW units under construction.

UNIT ON THE WAY



A DESIGN WHICH PROMISES FIRST COST SAVINGS AND LONG RANGE ECONOMY

Two Foster Wheeler steam generators with a combined steam capacity of 900,000 lb per hr are now being erected at Columbus and Southern Ohio's E. M. Poston Station, located at South Athens, Ohio.

A third and larger unit of the same design, recently ordered, will have a capacity of 625,000 lb of steam per hr.

These units are typical of the single-pass design which Foster Wheeler is using as the basis for "Preferred Standard" steam generators. This standardized steam generator pattern with fixed individual equipment details may be readily applied to a series of single or twin furnace units, varying in capacity from 300,000 lb of steam per hr to over 1,000,000 lb per hr. The design also embodies Foster Wheeler features of slag-free furnace arrangement, Foster Wheeler condenser-type steam temperature control, low draft loss, and efficient heat recovery equipment.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y

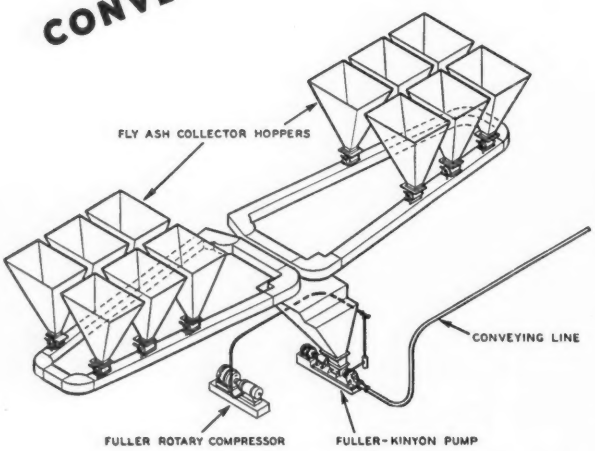
Third Foster Wheeler Unit for
E. M. Poston Station
of
Columbus and Southern Ohio Electric Company

Capacity	625,000 lb per hr
Superheat control range	450,000 to 625,000 lb per hr
Pressure superheater outlet	1350 psi
Final steam temperature	955 F
Bituminous coal pulverized in FW ball mills	

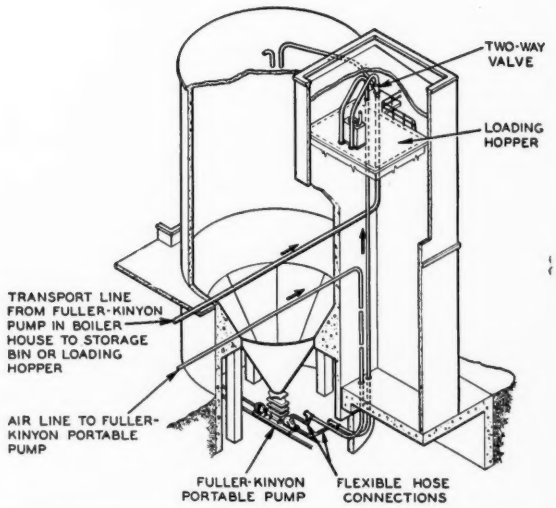
FOSTER WHEELER

Fly-Ash now an asset!

CONVEY WITH FULLER KINYON PUMPS

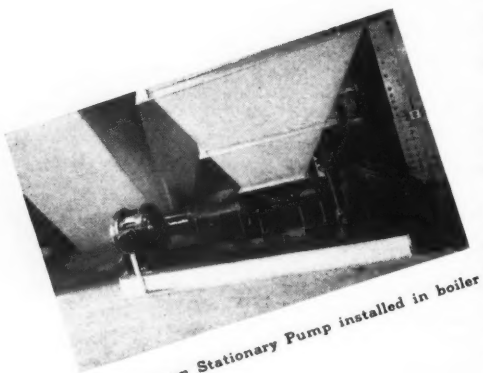


Fuller-Kinyon Pump conveying fly-ash from collector hoppers, in boiler house, to storage bin, or direct to hopper for bulk-car loading.


TWO-WAY VALVE
LOADING HOPPER
TRANSPORT LINE FROM FULLER-KINYON PUMP IN BOILER HOUSE TO STORAGE BIN OR LOADING HOPPER
AIR LINE TO FULLER-KINYON PORTABLE PUMP
FULLER-KINYON PORTABLE PUMP
FLEXIBLE HOSE CONNECTIONS

Fly-ash storage and handling facilities. Fuller-Kinyon Portable Pump for conveying from present storage bin, or future bins, to loading hopper for bulk-car loading.

CONVERT A COSTLY WASTE-PRODUCT INTO A PROFITABLE BY-PRODUCT



Fuller-Kinyon Stationary Pump installed in boiler house.

Fly-ash need no longer be considered a liability, to be disposed of by spreading it all over valuable property. You can now turn this so-called waste-product into a profitable by-product.

Several large power-generating stations are selling fly-ash to manufacturers of concrete products. It has been found that the use of this material is beneficial in the manufacture of cement bricks and blocks, concrete soil pipe, and ready-mixed concrete. Large quantities are now being purchased by manufacturers of these products.

Fuller-Kinyon Pumps are now in use in several generating stations for the clean and efficient handling of fly-ash. On this page is illustrated how a Mid-western generating station, using a Fuller-Kinyon Pump, conveys this material from collecting hoppers, in the boiler house, to either a bin for storage, or direct to car loading. A second Fuller-Kinyon Pump is also installed underneath the storage bin for conveying from storage to car-loading hopper.

Consult us about fly-ash conveying. We'll be glad to make a study of your conditions and suggest means to improve them.

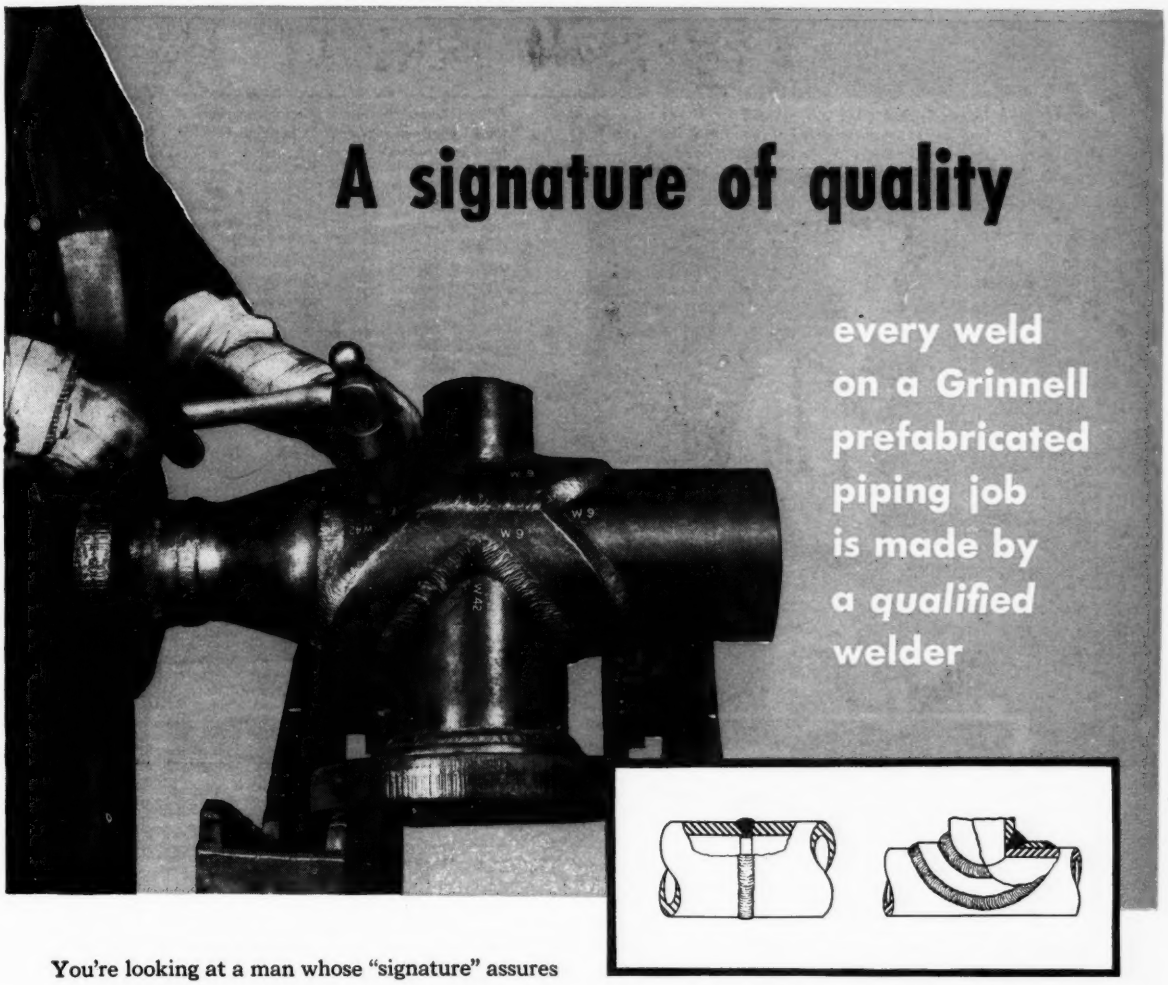
FULLER COMPANY, CATASAUQUA, PA.

Chicago 3 - 120 So. LaSalle St.
San Francisco 4 - 420 Chancery Bldg.

FULLER

FULLER-KINYON, FULLER-FLUXO, AIRVEYOR, F-H AIRSLIDE CONVEYING SYSTEMS . . . ROTARY FEEDERS AND VALVES . . . ROTARY COMPRESSORS AND VACUUM PUMPS . . . INCLINED-GRATE COOLER . . . DRY PULVERIZED-MATERIAL COOLER . . . MATERIAL-LEVEL INDICATOR . . . AERATION UNITS . . . AIRLIFT . . . CONSTANT-HEAD FEEDER . . . SLURRY VALVES MOTION SAFETY SWITCH . . . SAMPLERS

P-106



You're looking at a man whose "signature" assures quality welding of piping. He's a Grinnell welder and, as every Grinnell welder, he is qualified by Grinnell according to a procedure which conforms to A.S.M.E. Boiler Construction Code, Section 9. After qualifying, he is given a number which he "signs" adjacent to each weld he makes.

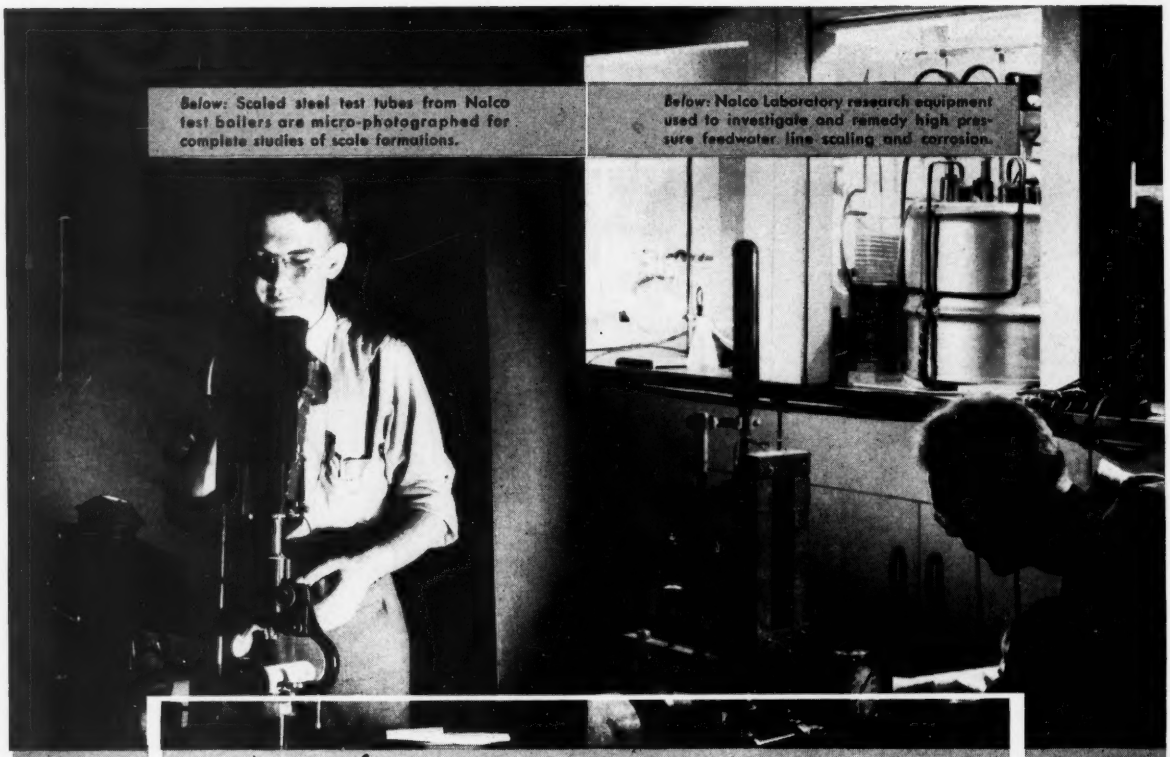
Quality welding is only one of a long chain of responsibilities assumed by Grinnell on every prefabricated piping job . . . from the interpretive engineering to the on-time delivery of the fabricated piping. Such responsibility requires facilities for metallurgical research and testing, comprehensive knowledge of state laws and industry codes, and a complete familiarity with insurance company requirements for fabricated piping.

The fabrication of piping for today's high pressure, high temperature or corrosive services is a job for experts. It's a job for Grinnell prefabricating plants because Grinnell has the modern equipment and methods, and the skilled personnel which enable them to assume total responsibility for the job.

99 YEARS PIPING

GRINNELL

Grinnell Company, Inc., Providence, Rhode Island. Branches: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston Long Beach • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

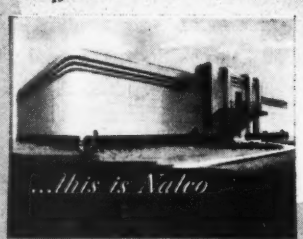


Below: Scaled steel test tubes from Nalco test boilers are micro-photographed for complete studies of scale formations.

Below: Nalco Laboratory research equipment used to investigate and remedy high pressure feedwater line scaling and corrosion.

Nalco SELLS WATER TREATMENT RESULTS

...businesses who trade Nalco ...always become Nalco ...system users if they are not already. Nalco personnel, equipment and facilities are illustrated and briefly described in the full-color book *This is Nalco* to show you why this is true. Your copy will be sent upon request.



NOT too many years ago, it was frequently more difficult to sell a program of water treatment results than to sell so-called cure-all boiler compounds. Today, Nalco's perseverance in selling results—and in producing continuously *better* results through basic research and development—has played a large part in bringing all water treatment chemistry to its present high standard.

In your plant, the Nalco System not only assures smooth-running, effective water treatment; but also provides expert assistance that helps lighten the important burden of water treatment responsibility.

Your Nalco Representative is available promptly to start the Nalco System in your plant. Call him today—or write direct for complete information.

NATIONAL ALUMINATE CORPORATION
6224 W. 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem, Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM...Serving Industry Through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Switchgear Bulletin** — Construction features of metal-enclosed low-voltage switchgear and drawout air circuit breakers are described in 8-pp Bulletin 18B6376A. It illustrates the self-supporting structure of the switchgear's framework, its pantograph construction, which provides an arrangement for withdrawing circuit breaker units, and other features. A chart supplies dimensions and typical panel data on the switchgear which is available in current ratings of 15 to 5000 amp, interrupting ratings to 100,000 amp, 250 v d-c and 600 v a-c. Bulletin points out that this switchgear can also be installed out-of-doors in which case it is enclosed in weatherproof housings. Allis-Chalmers Mfg. Co.

102 **Busway for Heavy Current**—A 4-pp circular explaining product features and advantages of manufacturer's LVD (low voltage drop) Flex-A-Power, describes it as a busway used principally as feeder lines for transfer of heavy current. Circular includes six installation photos showing applications where close voltage regulation was required. Also explains busway's cost cutting features—lower power losses, lower installation cost and lower maintenance cost. Back cover contains sectional photo narrow bus bar, streamlined housing, methods of fastening and construction. Available ratings and other necessary data are included. The Trumbull Electric Mfg. Co.

103 **Cutout and Switching Device**—Catalog Section 520, 8 pp, is devoted to the Positect, described as an enclosed bayonet type distribution cutout with high short circuit interrupting ability, current switching ability and special safety features. Booklet explains its construction and operation and includes applications, voltages and ampere ratings, also performance tables. Illustrated with photos of the device and fuse links, cutaway drawings and a dimensional sketch. Provides detailed ordering information. S & C Electric Co.

104 **Synchronous Motors** — High speed synchronous motors are described in this recently-issued 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors' rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

105 **Oil Circuit Breaker**—An oil circuit breaker—69 kv; 115 kv to 230 kv—for the electrical protection of high voltage transmission equipment, is decribed and illustrated in 8-pp Bulletin 71B6022C. Covers those features of the breaker—including its pole unit mechanism, electropneumatic operator for 20-cycle reclosing, 5-cycle arc interrupting devices and structure—which make for dependable protection, long life and low-cost maintenance. A table of dimensions is included. Allis-Chalmers Mfg. Co.

106 **Selenium Rectifiers**—This 28-pp bulletin presents the company's line of selenium rectifiers for electronic and electrical applications. It is devoted entirely to an exposition of the rectifiers' characteristics, applications and design factors. The fore part of the booklet contains complete descriptive material including rectifier circuits while the back portion consists of tables. Vickers Electric Div., Vickers Inc.

107 **Instrument Transformers**—A line of "butyl molded" current transformers is introduced in this 8-pp illustrated bulletin, GEA-5274. It explains the butyl molding technique involved in their production and why it has been adopted. It discusses the 5000-v indoor model which is the first of the line, describing in detail and illustrating by photos, the primary and secondary coils, interleaved core and heavy steel base. Lists ratings and includes graphs showing transformer accuracy up to 150 per cent of rated current. Apparatus Dept., General Electric Co.

108 **Instrument Transformers** — This 32-pp illustrated bulletin, 61B7168 presents engineering data on various types of the company's transformers—indoor and outdoor current type, indoor and outdoor potential transformers and outdoor metering outfits. Complete information on each type is presented including list prices. Allis-Chalmers Mfg. Co.

ENGINES, PUMPS AND ACCESSORIES

109 **Dual Fuel Diesels**—The construction and operational features of manufacturer's Diesel engines for use with either gas or fuel oil are discussed in 8-pp Bulletin 4811, which emphasizes the simplicity of conversion from one fuel to the other. It describes in detail and illustrates by photos three naturally aspirated models with ratings of 175 to 960 hp and two turbo-supercharged models with ratings of 505 to 1440 hp. Ratings and dimensions are given in tabular form. Superior Engine Div., The National Supply Co.

110 **Rotary Positive Gas Pumps**—Bulletin 32-33-B-13, 16 pp, discusses the advantages of rotary positive pumps over other types, explaining in detail their operational principle and presenting performance curves as evidence. Four standard models are described and illustrated by photo and sectional drawings; special attention is also given to gear and bearing details and stuffing boxes. Bulletin includes photographs of typical installations and a discussion of regulators and control systems. Roots-Connersville Blower Corp.

111 **Sand and Gravel Pumps** — Heavy-duty precision pumps in 1000 to 3000 gpm capacities for handling sand and gravel are described in this 4-pp bulletin. It contains photos and descriptions of all working parts and a sectional drawing to illustrate pump's operation. Full specifications and dimensions are provided. Kansas City Hay Press Co.

112 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

INSTRUMENTS AND CONTROLS

113 **For Practical Men**—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-

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City.....State.....

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Home Address.....

City.....State.....

shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on handling wet equipment. Photos, line drawings and humorous sketches accompany the text. James G. Biddle Co.

114 **Rotameter Bulletin** — Electronic, electric and pneumatic recording and controlling rotameters are covered in Bulletin 18-RC, 12 pp. Numerous photographs, cutaway views, sectional drawings, and functional diagrams accompany the explanation of the construction, operation and application of these instruments. Schutte and Koerting Co.

115 **NDHA Corrosion Tester**—This 12-pp illustrated letter-size booklet describes this famous corrosion tester in detail, tells why and how it it used. The tester contains three coils and is supported in a pipe or other enclosure to where amount of corrosion is to be determined. Springs are weighed on installation and again after suitable period of exposure to full operating condition. Loss of weight can then be evaluated in terms of corrosion. Various metals used. Bulletin contains full discussion of use, results under various conditions, typical examples. Water Doctor Laboratories.

116 **Megger Selection Aid**—A time saving selection chart and many practical hints that simplify the correct choice of an insulation resistance tester are included in Bulletin 21-05, 8 pp. Ten different types of Megger instruments covering ranges from 0.01 ohm to 10,000 megohms and including hand-operated motor-driven, rectifier operated, combination hand-operated and rectifier operated, and recording sets are discussed. Their applications in all major industries are described and many of these applications are illustrated by photographs. James G. Biddle Co.

COAL AND ASH HANDLING

117 **Coal Crushing Economy**—"Crushing Coal at Less Than One Per Cent per Ton," is the title of an 8-pp bulletin of interest to all power engineers who have a coal crushing problem. It gives the capacities, ratings and dimensions of a group of ring crushers designed to give better sizing control because they split the coal instead of crushing it. Illustrations and blueprints are included to show specifications and construction of these sturdy crushers, designed to crush large quantities of coal in one operation at low power consumption. American Pulverizer Co.

118 **Hydro Bins**—Dehydrating equipment for handling coke, ashes and similar material is described and illustrated by photographs in Catalog No. 1240, 8 pp. Photos show many of these bins now in industrial service, including several of the sectional plate cast iron type. Two are devoted to a discussion of manufacturer's water collecting anti-freeze gate. Allen-Sherman-Hoff Co.

119 **Ash Handling Equipment** — Catalog No. 1238, 8 pp, is devoted to cast iron ash hoppers and water collecting ash gates. It describes in detail and illustrates the construction of manufacturer's hoppers, water collecting gates and oil pumping unit for controlling power operated ash gates. Includes 2 pp of installation photos. Allen-Sherman-Hoff Co.

120 **Car Shakers**—Construction features, installation data and specifications on a new car shaker are presented in Bulletin 07B7221. Containing 6 pp, the bulletin lists typical applications, presents excellent illustrations and complete specifications and other data. Allis-Chalmers Mfg. Co.

121 **Coal Scale**—Form 61, 14 pp, covers manufacturer's re-designed automatic coal scale, describing its construction features and accuracy of operation and discussing the merits of its endless belt and by-pass construction. It is illustrated throughout with photos of parts and complete assembly, cutaway photos, and sketches. Three pages are devoted to engineering drawings and dimensions. Stock Engineering Co.

122 **Screw Conveyor**—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications and ordering information. Baughman Mfg. Co., Inc.

123 **Fly Ash Elimination**—Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed in detail, and so is dust collecting efficiency as affected by operating conditions. Book also contains excellent engineering data on single and double hopper installations and several diagrams of typical arrangements. Western Precipitation Corp.

PIPING AND ACCESSORIES

124 **Piping Unit Fabrication**—How unit fabrication meets today's trend in piping is explained and illustrated in 4-pp Bulletin AD-1771. It tells the advantages and economies of factory-unit fabrication of welded piping headers, assemblies and valve groupings into one-piece pre-tested unit. Plant facilities are discussed and sample unit-fabrications are illustrated and analyzed. Crane Co.

125 **Pressure Reducing Valves**—Complete information on a self-contained, pilot operated pressure reducing and regulating valves for use with water, air, refrigerating fluids and any non-corrosive oil or gas is furnished in 8-pp Bulletin 966. Illustrations include photos of the valves and cut-away views. Text tells how these valves work, how to establish ideal range; also describes construction features which contribute to operating efficiency. Includes dimensions, specifications and capacity charts for both liquids and gases. A. W. Cash Co.

126 **Pressure-Seal Valves** — Illustrated Catalog 12-H, just released, contains 12 pp of excellent information on cast steel valve designs with pressure-seal bonnets for high pressure and high temperature service. It presents all details of design, material specifications, pressure temperature ratings and charts for correlation of valve size and pressure drop. Covers globe and angle stop, non-return, and check valves in sizes 8 in. through 14 in. for 900, 1500 and 2500 lb pressure classes. Edward Valves, Inc.

127 **Expansion Joint Design Guide** — Titled, "A Design Guide to Expansion Joint Selection and Application," this is a 28-pp bulletin written in non-technical language and containing numerous illustrations, charts and tables. It was prepared to simplify the selection and application of expansion joints in piping systems. Contains data on sizes and types necessary to fulfill individual requirements of temperature, pressure and other conditions. Chicago Metal Hose Corp.

128 **Water Hose**—Manufacturer's line of water hose for industrial service is pictured and described in detail in Catalog Section 4800. It covers hose for pressures up to 250 psi and for use with hot or cold water. Provides specifications, coupling information; gives recommended uses. The B. F. Goodrich Co.

129 **Expansion Joints for Extreme Conditions**—Illustrated Bulletin EJ-49, 8 pp, was prepared to give engineering and product information to power engineers dealing with piping where pressure and temperature extremes exist, and where pipeline expansion under working conditions is a prime consideration. Information covers both "free-flexing" and "controlled-flexing" corrugated type expansion joints in copper and stainless steel construction for temperatures up to 900 F and pressures up to 300 psi. Ordering information included. Chicago Metal Hose Corp.

130 **Insulation Handbook**—Available this month to power engineers having a direct interest in industrial heat insulation is a 96-pp manual on 85 per cent Magnesia insulation, illustrated with line drawings and photographs. Among the subjects covered are: properties of 85 per cent Mag-

(Continued on page 110)

JULY, 1949

POWER GENERATION

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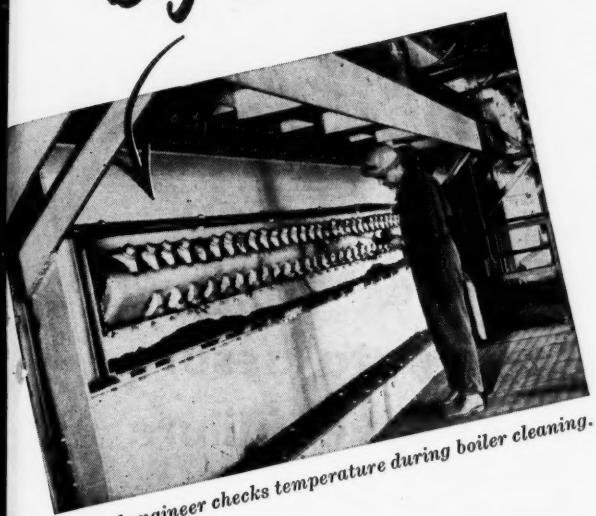

Dowell engineer checks temperature during boiler cleaning.

A TYPICAL EXAMPLE of the economies afforded by Dowell Service is reported in the case of a midwestern refinery using five 300,000 lb. per hour boilers to generate electrical power. Before Dowell Service was used in the plant, boilers were usually down two weeks whenever repairs became necessary—during which time electricity was purchased from an outside source. Using Dowell Service to do the internal surface cleaning, the boiler is back in use in one week instead of the usual two! And the Dowell part of the operation takes just one day!

Quick, Effective Maintenance Service Cuts Total Down Time in Half

Dowell Service, using the experience of thousands of successful jobs, offers you the solution to maintenance problems of this type. It is backed by strong, continuous research programs, both in Dowell's own laboratories and in those of The Dow Chemical Company. This research provides the means for an improving service with an increasing degree of effectiveness and safety.

When you call on Dowell Service for your maintenance cleaning, experienced Dowell engineers do the job for you. They bring the special equipment—truck-mounted tanks, mixers, heaters, and proportioners—necessary for controlled cleaning. No dismantling or scaffolding is required. Liquid solvents are pumped into the equipment through regular connections. Down time is held to a minimum.

For quick, practical, economical cleaning of boilers, heat exchange equipment, water lines and water wells, call the nearest Dowell office. Free cost estimates gladly given.

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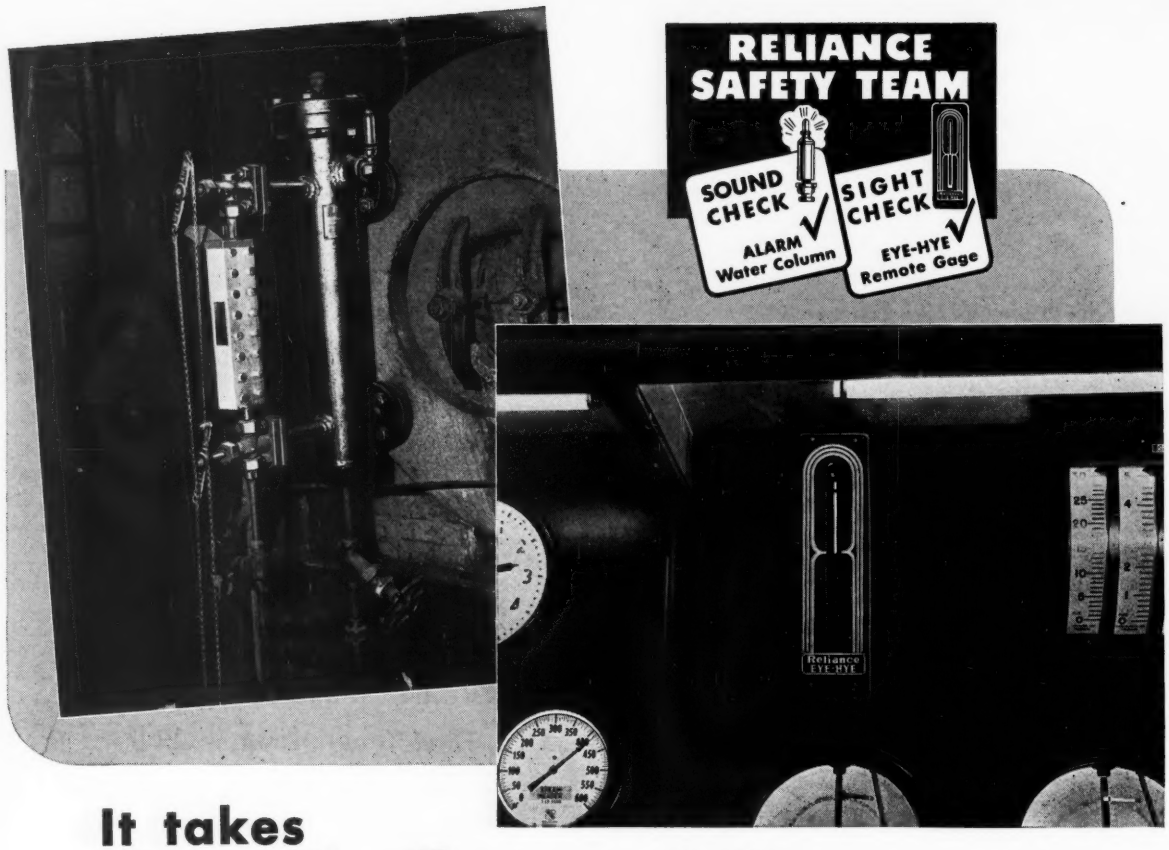
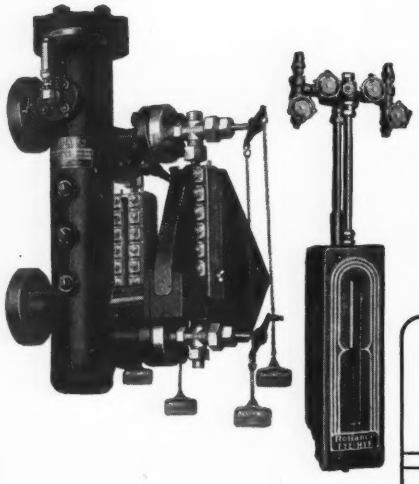
A SERVICE ORGANIZATION



It takes *Double Supervision* to assure full safety from boiler water level failure

Reliance Alarm Water Column

EYE-HYE Remote Reading Water Level Gage



Prevent boiler outage and expensive water level accidents. Have *adequate* boiler water supervision . . . so easy to obtain with the Reliance Safety Team. The automatic alarm water column, originating with Reliance back in 1884, has saved many thousands of boilers from explosion or damage. Its sensitive mechanism acts instantly to warn operators when dangerously low or high water levels develop.

That's the final warning. You don't want to hear it, so you make doubly sure water levels are safe by keeping tab on the gage reading. But gages high on the boiler may be hard to reach, or difficult to see clearly. EYE-HYE Remote Reading Gage is the answer. Mount it at eye height, on wall or instrument panel. Its illuminated green indicator is hard to miss.

EYE-HYE is a sturdy, dependable instrument, yet one of the most simple. Calibration set at the factory to suit your conditions . . . can't be tampered with. Ask your nearest Reliance Representative about the Safety Team, or write to the factory.

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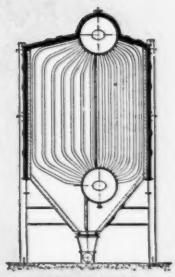
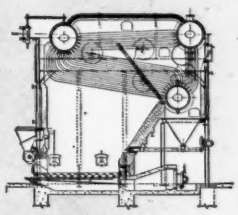
STEAM GENERATORS FOR ALL INDUSTRY

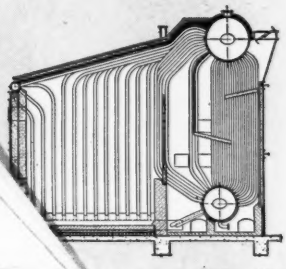
Wickes Steam Generators are in constant daily service in thousands of installations throughout the world. Wickes can fill your exact requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 psi. • Wickes Boilers are engineered for use in oil, chemical, paper and many other industrial uses. Our knowledge of steam generation is available for your consultation, without obligation. Descriptive literature available upon request.



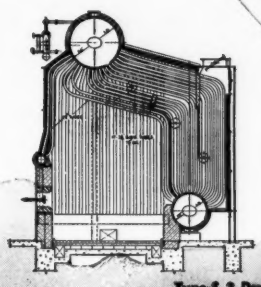
Wickes 2 Drum Waste Heat Installation



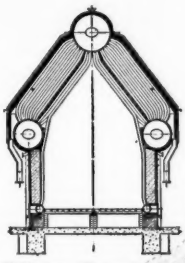
3 Drum Low Head Water Tube Boiler



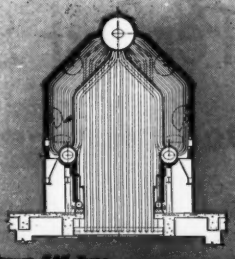
2 Drum Water Tube Boiler



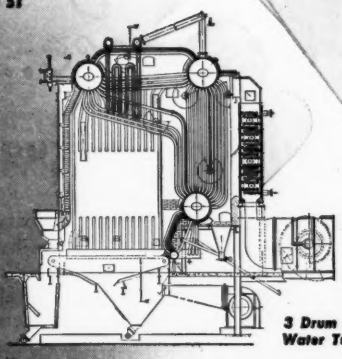
Type-S 2 Drum Boiler Series S1



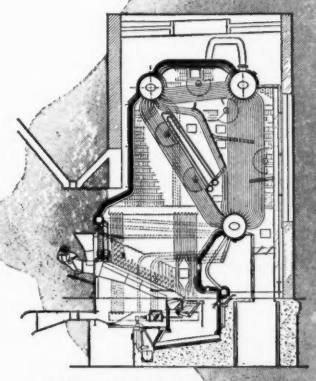
"A" Type Water Tube Boiler



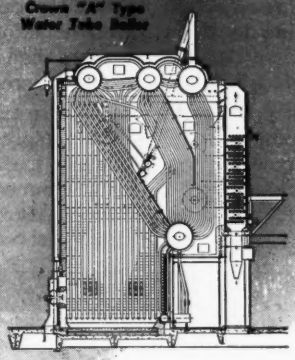
Crown "A" Type Water Tube Boiler



3 Drum "B" Type Water Tube Boiler



3 Drum Water Tube Boiler



4 Drum Water Tube Boiler

THE WICKES BOILER CO.

SAGINAW, MICHIGAN

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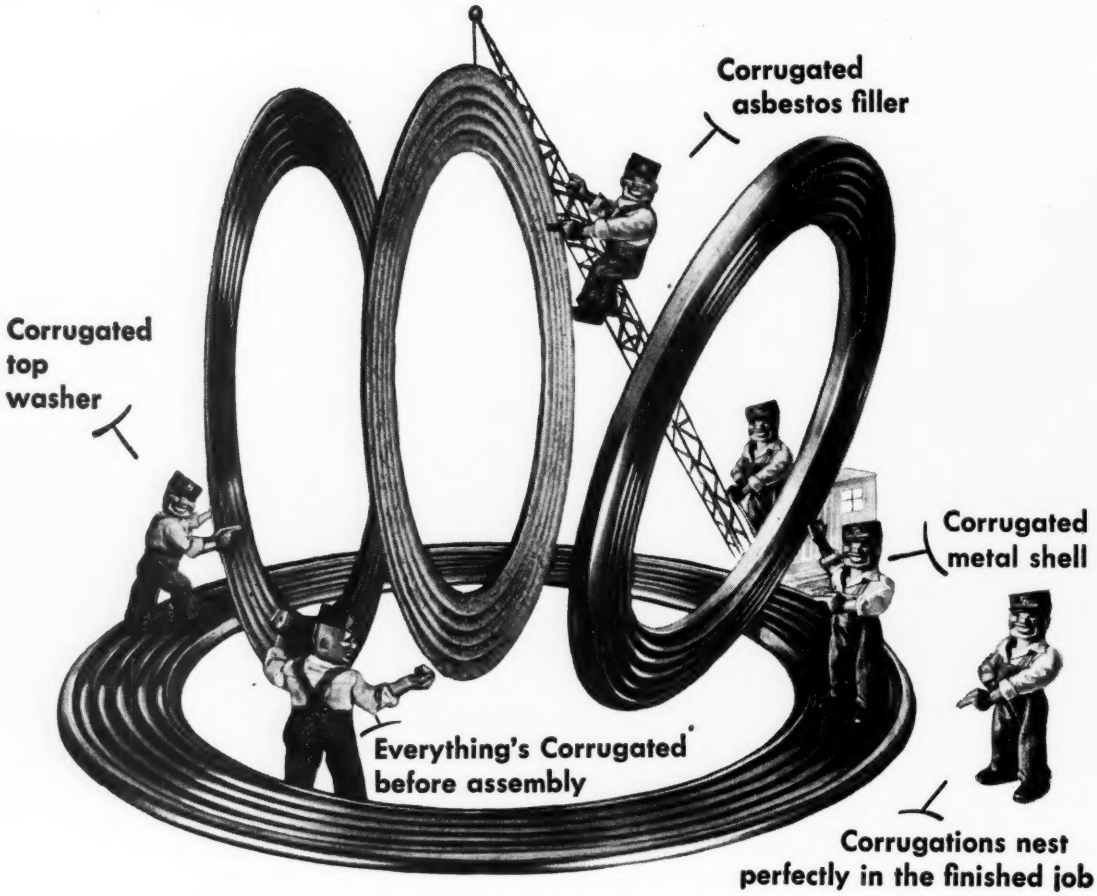
Corrugated asbestos filler
Corrugated top washer
Corrugated metal shell
Everything's Corrugated before assembly
Corrugations nest perfectly in the finished job

Greater Strength... More Resilience... Perfect Sealing!

...with this corrugated metal-asbestos gasket

IN THE FABRICATION of the Goetze Style 926 metal-asbestos gasket shown here, each of the three units is corrugated *individually* to assure perfect "nesting" and matching in the assembled gasket.

This results in greater strength and resilience . . . and better sealability under high pressure. For these reasons, this gasket is recommended and widely used in chemical plants, power stations and oil refineries, especially where destructive elements are encountered.

Goetze custom-made gaskets—such as Style 926 above—pay off in the long run because of the meticulous care that is taken with every detail of construction . . . care and skill that is based on more than sixty years of meeting the specialized gasket requirements of industry.

If you're seeking a gasket that will not have to be replaced so often—in standard or non-standard sizes—we will gladly furnish estimates and recommendations on request. Write Johns-Manville, Box 290, New York 16, N. Y.

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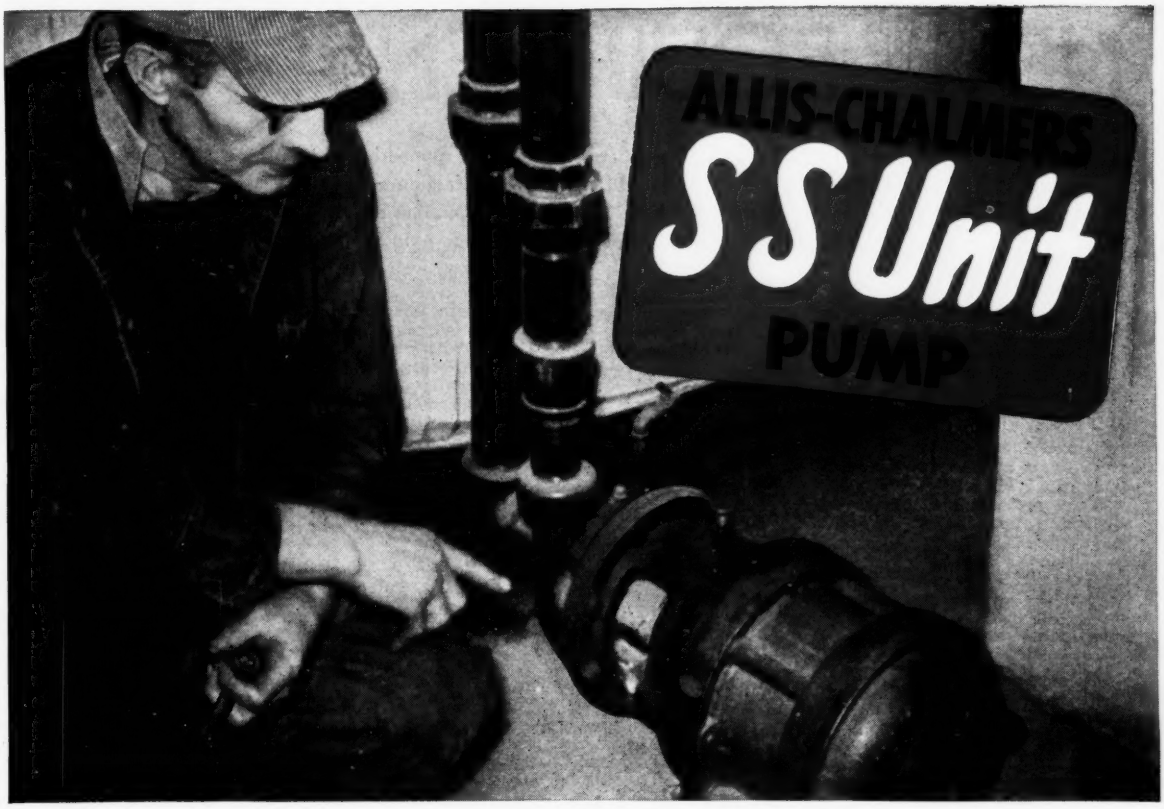
THERE'S A JOHNS-MANVILLE PACKING OR GASKET FOR EVERY SERVICE



7 Years ... NO REPAIRS!

SS Unit Pump on 24 hour, intermittent 7 day duty in power plant gives equivalent of 20 years normal service with *no* repair cost, *no* lost time

SINCE EARLY 1942 this SS Unit pump has been on continuous duty in a large mid-west plant. Never once in all this time has it failed to operate perfectly. Outside of normal repacking, not one cent has been spent on repair.

Here's *proof* that the extra-strong design, extra-heavy construction and extra-quality manufacture of Allis-Chalmers pumps give you dependable performance and low pumping costs.

Compare SS Unit features with any similar pump. Notice how SS Unit is compact, yet open for easy maintenance. Motor and pump are solidly bolted together using the same shaft. This design holds alignment rigidly . . . reduces vibration . . . cuts wear and tear. Every A-C pump is tested at the factory. Full rated efficiency and output are *guaranteed*.

SS Unit is one of many Allis-Chalmers pumps for industrial service. For complete information, see your Allis-Chalmers Authorized Dealer or Sales Office, or write for Bulletin 52B6059E. Also in Sweet's.

SS Unit, Texrope and Vari-Pitch are Allis-Chalmers trademarks A-2660

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CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

NEW EQUIPMENT NEWS

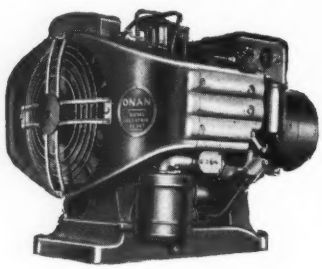
WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other infomation desired. For ease in making requests use the no-obligation, postage-paid card, pages 35-36

1—5 KW DIESEL PLANT

Is air-cooled engineered to produce low-cost electric power

The smooth, vibration-free operation of this new 5000 w, a-c Diesel Electric Plant, Model 5 DRP, is credited to its prime mover—an opposed two-cylinder, air cooled Diesel engine, said to run so smoothly it requires no bolting down or special base. Integral shock mountings are provided to make it possible to operate this unit right on the floor. Plant's dimensions emphasize its compact design: length 28¾ in., width 30¼ in., and height 26⅛ in. Air cooling helps to keep its weight down to approximately 725 lb, less batteries.

Adaptable to portable applications, the 5 DRP is available in 60- or 50-cycle and in standard voltages. Longer



engine life is promoted by extra-large bearing surfaces and forced pressure lubrication: greater economy and convenience by compression starting and running on inexpensive Diesel or domestic fuel oils. Air-cooling and oversized (6 qt) oil sump are said to keep servicing requirements at a minimum. Two large oil bath air cleaners and a primary and secondary fuel filter are standard equipment.

Two intake air manifolds have built-in electric heaters operating from starting batteries.

Standard equipment on the plant also includes two 6 v heavy-duty starting batteries, battery cables, hydrometer, mounting rubbers, 5-gal fuel tank, two flexible fuel lines, muffler, two air heaters and a remote station. D. W. Onan & Sons Inc.

2—SERVICE COCKS

For working pressures up to 125 lb on gas, oil or water lines

These new, high-pressure lubricated service cocks are described as being practically tamper-proof. Available in ¾- and 1-in. sizes, they have cast iron bodies and bronze plugs, and are made with both screwed recessed ends and Dresser super service ends. As in other types of high pressure lubricated plug vavles, the plug is held against its seat in the body by a gland through resilient packing. This packing has five layers —the top and bottom layers consisting of copper-silicon-maganese bronze diaphragm; second and fourth of sheet asbestos gaskets, and the middle layer of synthetic oil-proof rubber, ¼-in. thick.

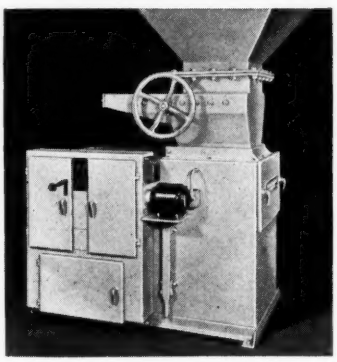
The bottom of the cock is a continuous casting, and the top is closed by means of a screw-type bronze gland, which requires a special spanner wrench, also required to disassemble this cock. It is pointed out that an unauthorized person would not have such a wrench. Bodies and plugs are fitted for tightness and provided with a lubricant screw of cadmium-plated steel, and complete lubricant grooving system for "pressure-sealed" lubrication. The lubricant chamber has a spring-loaded ball-check valve unit of case-hardened steel with hardened steel ball and music wire spring. This unit is designed to prevent back flow when lubricant screw is removed. A built-in double stop is provided in the bottom lubricant well to limit the movement of the plug to 90 deg. Wal-

worth No. 517 stick lubricant is used, a type recommended for valves on manufactured and natural gas services and said to be suitable for wet or dry gas, propane, butane, or gas condensates at temperatures from –20 to +212 F. Walworth Co.

3—COAL SCALE

Is built for fully automatic operation and accurate weighing

Described as absolutely dust-tight, the coal scale consists of three major assemblies: a belt feeder with skirt bars to keep coal on the feeder; a weigh



lever with pivots, complete with counterweight, tare adjustment and compensator; a weigh hopper with bottom dump gate and closing mechanism.

Its operation is simple. When the weigh hopper gate is closed, the hopper limit switch closes the control circuit which, in turn closes the motor starter. This energizes hopper gate solenoid to release brake, and motor to start feeder. When weight of coal in weigh hopper becomes greater than balancing force, the weigh lever raises, thus opening mercury switch (in compensator) which opens control circuit. The brake is set, the feeder is stopped and the gate is released to discharge the weighed coal into hopper below. When enough coal is used to release the gate, the gate is closed by the counterweights and the cycle repeated.

A test switch, which prevents weigh hopper gate from opening and provides time for scale lever to seek its balance, allows test engineer to observe if scale is weighing accurately or if weight is over or under. If weight of coal in hopper is incorrect, operator moves the compensator knurled nut out or in, as required, to bring scale into prefect adjustment. Other features of the scale include totally enclosed ball-bearing motor; easily operated by-pass; sampling door, and endless belt. Stock Engineering Co.

4—CONTINUOUS PYROMETER

Monitors cylinder exhaust temperatures of Diesel engines

The Alnor 1160 Pyrometer is designed for automatic measurement of Diesel exhaust temperatures and for operation with minimum maintenance for many years. A large, clock-like dial indicates switch positions and is readable 20 ft away. Switch has a motor-driven, rotary-type arm, actuating leaf type contact assemblies. Overlaps in the rotary

USE THE NO-OBLIGATION, POSTAGE-PAID CARD ON PAGES 35-36

the SOURCE you can depend on for all your Piping Needs

How CRANE is set up to give you better service

Take the water supply piping shown here, for instance. First, in one **complete line,** Crane gives you the largest selection of equipment—**valves, fittings, pipe line accessories, and pipe.** The Crane Catalog makes it easy to specify—**easy to order**—all piping materials for your installation.

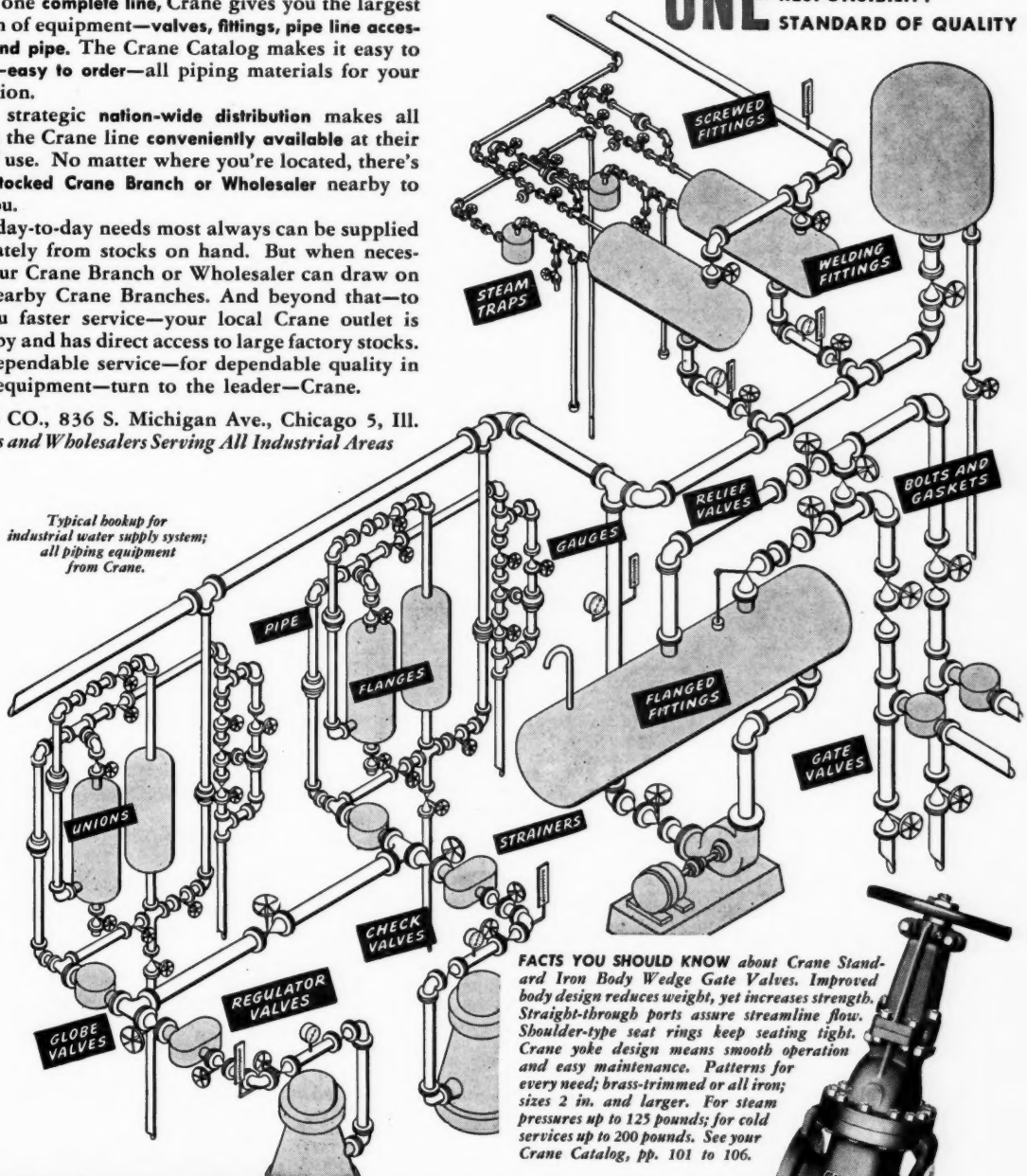
Next, strategic **nation-wide distribution** makes all items in the Crane line **conveniently available** at their point of use. No matter where you're located, there's a **well-stocked Crane Branch or Wholesaler** nearby to serve you.

Your day-to-day needs most always can be supplied immediately from stocks on hand. But when necessary, your Crane Branch or Wholesaler can draw on other nearby Crane Branches. And beyond that—to give you faster service—your local Crane outlet is backed by and has direct access to large factory stocks.

For dependable service—for dependable quality in piping equipment—turn to the leader—Crane.

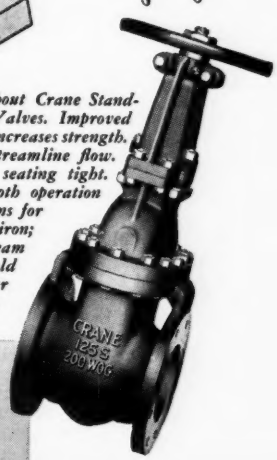
CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Typical bookup for industrial water supply system; all piping equipment from Crane.

FACTS YOU SHOULD KNOW *about Crane Standard Iron Body Wedge Gate Valves. Improved body design reduces weight, yet increases strength. Straight-through ports assure streamline flow. Shoulder-type seat rings keep seating tight. Crane yoke design means smooth operation and easy maintenance. Patterns for every need; brass-trimmed or all iron; sizes 2 in. and larger. For steam pressures up to 125 pounds; for cold services up to 200 pounds. See your Crane Catalog, pp. 101 to 106.*



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CRANE

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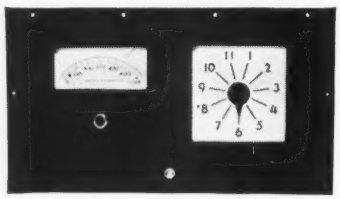
switch keep pointer from returning to zero between positions. Any large deviation shows immediately on pyrometer scale, it is pointed out.



A push button on front panel enables operator to stop rotating switch on any selected position for longer readings. Rotation speed is 1 rpm. Pyrometer can be equipped with an excess temperature cut-out which activates various alarm systems or engine shutdown controls if any cylinder should reach excessive exhaust temperatures. Illinois Testing Laboratories, Inc.

5—SMOKE ABATEMENT

Injects secondary air into fire and mixes it with unburned gases

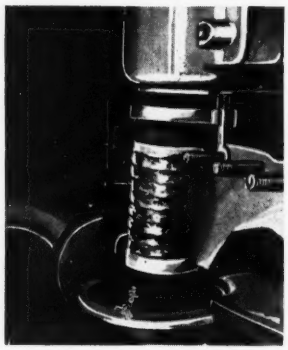
In the PliOjet system jet air streams are forced into the firebox where and when needed to provide necessary air and turbulence to mix the volatile gases with the oxygen and obtain complete combustion. This system is described as a practical means of introducing secondary air through over-fire air jets arranged in sets. Ten standard

sets make it possible to select an arrangement that will provide adequate penetration at maximum firing rate according to individual requirements, it is said, and installations are engineered and installed according to prevailing conditions. Illustrations show the PliOjet over-fire air system, including turbo-blower, conductor pipe, manifold and high-temperature alloy jet nozzles. Plibrico Jointless Firebrick Co.

6—WOOD-METAL PACKING

Is designed to permit operation with a minimum of friction

Wood-Metal Packing employs tiny reservoirs of wood to hold and distribute lubrication. It is described as forming a bearing-like, lubricated surface the entire length of the stuffing box. Because of its low friction and tighter seal, no further sealing devices are necessary, according to manufacturer, whose records show installations of this packing in continuous operation for over 15 years without leaking or repacking. Available in the super-heat bracket that withstands temperatures over 1200 F, in special packings for caustics, acids, gas, oil, milk or similar

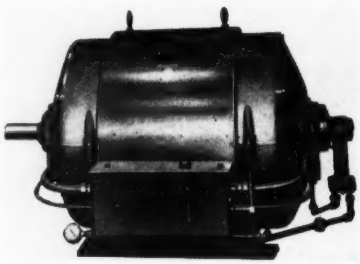


services, and in standard packing for ordinary jobs. Illustration shows the shaft of a centrifugal pump, in which the hood has been removed to show how packing appears after 15 yr of interrupted service. Rains Wood-Metal Packings.

7—FEEDWATER PUMP MOTOR

Two-pole squirrel cage induction type features pressure lubrication

Available up to 1,250 hp, this two pole 3600 rpm motor of drip-proof construc-



tion with pressure-lubricated bearings, finds one of its main appications as a boiler feedwater pump motor in power plants. The bearings use pressure lubrication furnished by a pump worm-geared to the motor shaft. The pump draws oil from the reservoir at the side of the motor and pumps it into the two bearings. The high pressure side is also by-passed to the oil reservoir, and there is a preset orifice in this line to control the proper flow of oil. Bearing drainage to the oil reservoir is through the large pipes. Electric Machinery Mfg. Co.

8—BOILER DE-SCALER

Is developed to purify hard water through electrolytic action

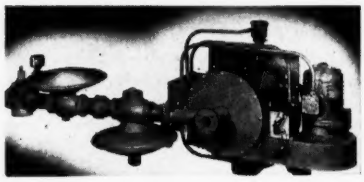
The De-Scaler is intended to lengthen the life of a boiler tube and cut maintenance cost. The unit consists of a silver-plated copper case within which is a special cartridge. Electrolytic current is generated within the unit, with the container acting as a cathode and the cartridge as an anode. Water circulating through the De-Scaler furnishes the carrier. The action thus created within the unit tends to overcome lesser electrolytic effects of other metals in the boiler.

The cartridge is said to have a greater affinity for free oxygen than other metals in the boiler and bears the brunt of corrosive attack. The De-Scaler thus operates to produce water no longer hard, which prevents formation of new scale and causes scale already hardened to soften and fall to the bottom of the boiler. Butler Engineering Co.

9—BOILER BURNER

Is packaged unit in two sizes, for installation in old or new settings

Known as Series 115, Boiler Burner, this packaged-unit is available in two sizes: the 115-2.5 for 2½ million Btu input and the 115-5 for 5 million. (Approximately 50 and 100 developed boiler hp, respectively.) All combustion air is furnished through the burner by a blower which is an integral part of the burner. This is designed to give com-



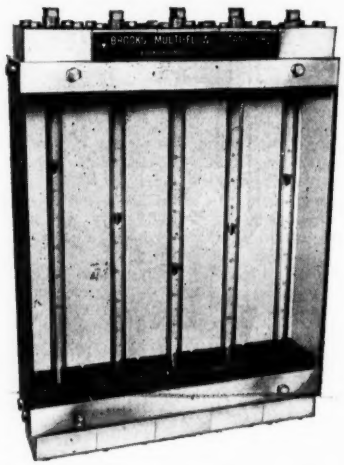
plete fuel-air ratio control and assure maximum heat output of any fuel used. Furnished complete with a control panel incorporating safety devices, the unit with modulating control is entirely automatic.

Installation is simple. Piping consists of only the gas line, and wiring is well marked for connecting the few wires necessary. Mounting of the factory-assembled unit to the boiler presents no difficulty in that it is light in weight. Operation of the Series 115 boiler burner is described as exceptionally quiet and clean and requiring practically no servicing. The North American Mfg. Co.

10—MULTI-FLOW ROTAMETER

Can be built with two or more tubes for use on related flows

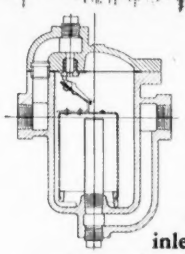
In this unit the standard Full-View Rotameter end fittings are fastened to a metal back plate with dowel pins and cap screws. The front of the unit is shielded with a plastic window, ¼ in. thick. Each tube with its fittings may be removed without disturbing any of the other parts. Advantages of the unit include compactness, close correlation



of related flows, and economy. It costs less than the same number of individual rotameters.

It is reported to be proving effective for such applications as reflux and product in a continuous still, gas and air flows to an atmosphere furnace, water to a battery of coolers, continuous dilution, continuous purging, feed

"Best little steam trap on the market"
The Armstrong No. 800
FOR draining condensate from Sterilizers . . . Laundry Presses . . . Coffee Urns . . . Vegetable Steamers . . . Risers . . . Supply Headers . . . Radiators . . . Coils . . . Unit Heaters Dryers . . . Cookers . . . Steam Tables . . . Press Platens . . . and similar equipment in laundries, restaurants, institutions, hospitals, greenhouses and processing, food and general industrial plants.



THE little Armstrong No. 800 trap for pressures to 150 psi is the modern version of the Armstrong No. 100 trap which was introduced way back in 1931 as the first small, heavy duty, side-inlet, side-outlet mechanical steam trap ever manufactured for small drips. The most widely used industrial steam trap in the world, it is also one of the most widely imitated, but only the Armstrong No. 800 offers all these advantages:

- Interior mechanism identical in material and workmanship to that in Armstrong traps for 1500 psi, 900° F.
- *Actual tested hot condensate capacity* from 450 to 690 lbs/hr continuous, depending on pressure.
- Free-floating, frictionless leverage system.
- Hardened chrome steel valve and seat.
- 18-8 stainless one piece deep drawn bucket.
- Only 5" x 5⅛" overall; weight 4½ lbs.
- Price only $7.00 list.

The Armstrong No. 800 is *unconditionally guaranteed to give complete satisfaction or your money will be refunded.* Your local Armstrong representative carries these traps in stock and will give you prompt attention if you will call him today. Send for your copy of the 36-page Armstrong Steam Trap Book.

ARMSTRONG MACHINE WORKS, 810 Maple St., Three Rivers, Mich.

ARMSTRONG *Inverted Bucket* STEAM TRAPS

***For fuel savings, low maintenance, automatic air removal* SPECIFY ARMSTRONG!**

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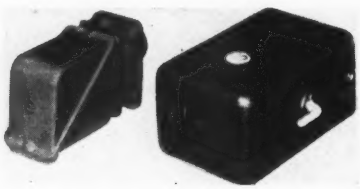
to parallel filters and other services where two or more flows have a direct relationship to each other. Brooks Rotameter Co.

11—COMBUSTION SAFEGUARD

Provides automatic programming and protection for oil burners

To protect commercial-size oil burners from flame failure and provide automatic programming for them, the Fireye System FF-1 includes Photoelectric Scanner Type 45PH5 and Programming Control Type 24PJ8. The scanner consists of phototube and vacuum tube amplifier housed in a compact, dust-tight aluminum case. It is mounted on the burner so it has a clear view of the oil flame and, when flame fails, it instantly signals the programming control. This is provided to start burner



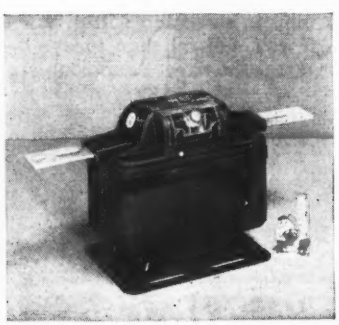
in operation automatically and program a sequence of fuel valve opening, post ignition time, priming and scavenging.

The optical system on the scanner has a special heat-absorbing filter and a hinged shutter to permit lens cleaning without shutdown. It is small, but rugged and said to be immune to moisture and electrical leakage. Timing cams on programming control are driven by a high-torque synchronous motor. Fuel valve delay and post ignition periods can be set quickly upon installation. All power handling contacts have snap action on opening and closing. Normal electrical wiring is used between scanner and programming control. Supply voltage—115/230 v, 60 cycles; load rating—burner motor, 1 hp, 115/230 v 60 cycles. Combustion Control Corp.

12—BUTYL-MOLDED TRANSFORMER

Is designed for accurate indoor metering and relay services

This instrument current transformer, the JKM-3, is rated 5000 v at 25-60 cycles, and will be available with single



primary in all preferred ratings, 10 to 800 amp inclusive. The butyl compound, injected under high pressure into the areas around the core, coils, and terminals, provides a homogeneous insulation described as resilient, oxidation-resisting, arc-resisting, and highly resistant to moisture.

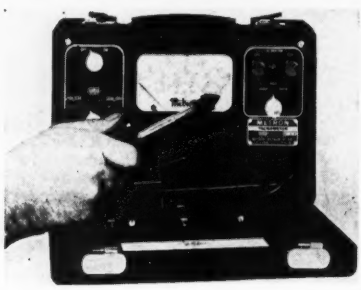
Interleaved-core construction is used to eliminate possibility of reduction of accuracy resulting from mechanical shock caused by short circuits or careless handling. Primary terminals, silver-plated to reduce contact resistance, each have one bolt-hole and a slot to facilitate connection to various-size cable lugs. Secondary terminals are solderless clamp type. Transparent plastic terminal cover is so built that it cannot be put in place when short-circuit switch is closed and meters or other devices are connected. The JKM-3 is interchangeable with other transformers. Meter and Instrument Divs., General Electric Co.

13—PRECISION TACHOMETER

Has range especially suited for motor and generator testing

The new Type 48K Precision Tachometer has a total speed range without adapters of 360 to 4000 rpm for accommodating synchronous or induction motors and most geared type motors. Head adapters are available for checking high speed universal motors or extreme low speed gear motors.

Any of the 10 ranges is instantly selected by rotary switch, it is said, and no damage results from overspeeding up to about 8000 rpm regardless of range setting. Readings are guaranteed accurate on all ranges to within ¼ per cent of actual speed. A bridge circuit principle is employed to obtain high accuracy and a self-calibrating circuit is

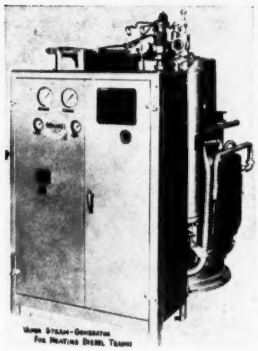


built in to provide long-time stability. Described as ideal for accurate production testing. Permanent lubrication, no limited-life components, low-torque operation and rugged construction are intended to promote long service life and trouble-free opeartion. Metron Instrument Co.

14—VAPOR STEAM GENERATOR

Is designed to develop full working pressure from cold start in 2 min

Over 200 lb steam pressure within 2 min is reported possible with the Intensi-Fired Steam Generator Model OK-4625. In it, hot gases from a new type of fire, burning atomized Diesel oil, releasing 1,000,000 Btu per cu ft of fire box, sweep over the 500 ft of seamless steel tube coils, developing 2500 (plus 20 per cent) lb of steam per hr, according to manufacturer. One electric motor, drawing 2 amp per 100 lb of steam, operates the fuel and water pump, blower and ignition system. Cy-



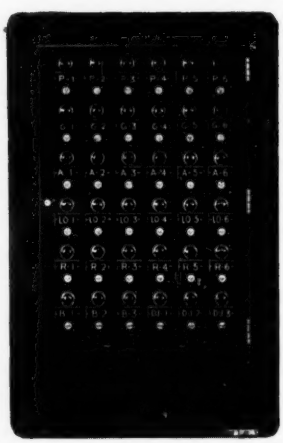
cles off and on automatically to maintain desired working steam pressures between 75 and 250 lb. Construction conforms with ASME and Hartford Steam Boiler codes; coils all given 1200 lb hydro test. Overall size is 40 in. wide, 68 in. long and 73 in. high. Vapor Heating Corp.

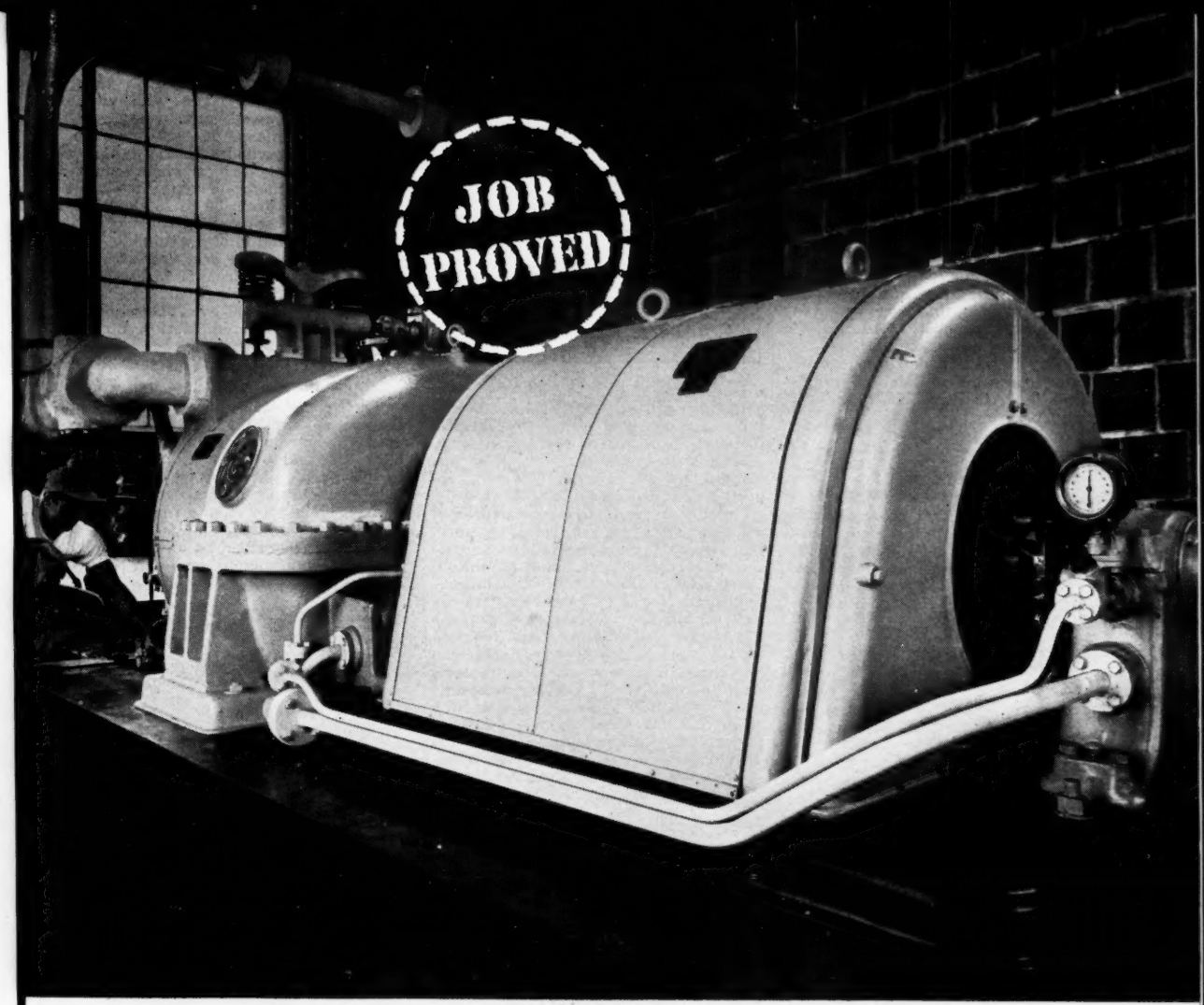
15—ANNUNCIATOR

Uses both visual and audible alarms to signal warnings

This supervisory annunciator is recommended for signalling overheated bearings, low fuel level, too high or low pressures, too high air cooling temperatures and the end of processing cycles. When trouble occurs the Bull's-Eye Lamp Type Annunciator receives an electrical impulse from a normally open or normally closed, momentary contactor, such as a thermostat or float switch. This impulse causes a maintaining contact in the annunciator circuit which operates a visible signal indicating on the board where trouble is developing and, simultaneously, sounding an alarm. This annunciator is said to be especially valuable for public utilities, refineries and large industrial plants, since it is intended to permit centralized control of trouble spots and prevent breakdowns.

Designed for flush or panel mounting, open or closed circuit operation, on voltages from 24 to 250 v, a-c or d-c, as specified. Audible signal is a 3-in. heavy duty bell, (or horn), for external mounting. Visible signals are 1 in. bull's-eye lamps, electrically operated, electrically held and self-sealing in operating position. Engraved lamacoid plates identify lamp circuits. Audible alarm is silenced by operation of trans-





CORROSION THREAT ENDED BY SUNVIS 916

Turbine Under Intermittent Operation Gets Year 'Round Protection

A utility company serving an island summer resort operates an auxiliary turbine at peak capacity throughout the vacation season. But for the rest of the year, this equipment is shut down and corrosion is a constant threat. An oil is required that will keep the equipment running under the heavy summer load, and maintain it ready for instant use in case an emergency should arise during the off season.

More than two years ago, acting on the advice of a Sun engineer who had been consulted, the company filled the circulating system of its turbine with Sunvis 916 Oil. The unit is still running on the original charge and inspection shows complete absence of corrosion.

There has been no perceptible wear of parts. The Sunvis 916 Oil is in excellent condition and only slight make-up has been required to take care of normal leakage.

This is but one of many examples of how "Job Proved" Sunvis 900 Series Oils protect vital and expensive machinery. They are highest-quality, solvent-refined oils, specially manufactured to resist oxidation and sludging, and to protect metal parts against rusting and corrosion. For a copy of the illustrated booklet "Sunvis 900 Oils," write Department PN-7.

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fer switches; visible signal is reset by push button.

Standard finishes are dull black or wrinkle gray. Operating parts are protected against dirt, dust, moisture and corrosive fumes, but assemblies are accessible for inspection and repair. Annunciator conforms to latest requirements of the AIEE and NEMA. Auth Electric Co.

16—ACROSS-THE-LINE STARTERS

Manual type in two sizes for use with single or polyphase a-c motors

Compact in construction these manual starters consist basically of a mechanically quick make and break switch mechanism with thermal overload protection. Components are housed in NEMA Type 1 general purpose enclosures.

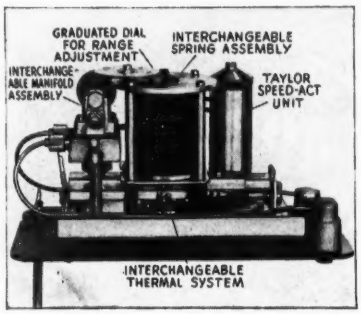
Features include: front operated, silver to silver double break contacts, manually reset inverse time delay thermal overloads, interchangeable overload heaters, provision for padlocking and adequate wiring space. All are available in two-, three- and four-pole forms. Maximum enclosed three-phase rating for Size 0 is 2 hp, 440-500 v, 60 cycles; and for Size 1, 7½ hp, 440-550 v, 60 cycles. Ward Leonard Electric Co.

17—TEMPERATURE TRANSMITTER

Is a highly responsive, force-balance type pneumatic instrument

The Transaire with Speed-Act is designed particularly for applications where indication, record or control should be remotely located from point of measurements and where accuracy, high speed of response, small thermal elements and short range spans within limits of minus 375 F and plus 1000 F are necessary. An outstanding feature is the incorporation of Speed-Act which applies principles of pre-act or derivative action directly to temperature determination. This is intended to overcome the lag considered inherent in the response of any form of thermal measuring element.

Wherever pneumatic temperature transmission can be used advantageously (usually when distance between point of measurement and location of recording or controlling mechanism is 50 ft or more) this instrument provides



a responsive and dependable means of detecting process temperature variations. Its output in psi is proportional to temperatures of its thermal element, and by means of ¼ in. OD copper tubing, this pressure change can be transmitted to a receiver as far 1000 ft away.

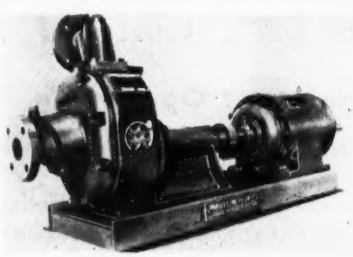
Other features include rapid speed of response; small thermal elements; short range spans for closer readings; adjustable operating ranges; fixed air output range of 3 to 15 psi for full temperature span, linear to 0.1 per cent to assure repeatability of readings; compensation for barometric and ambient temperature changes; interchangeable unit assemblies and thermal systems built to withstand overrange temperatures up to 1000 F. Transmitter is fully encased. Convenient brackets provided for pipe or wall mounting, or an adjustable bracket is supplied when instrument is used with separable bushing. Taylor Instrument Companies.

18—CENTRIFUGAL PUMPS

Many types are now available as manufacturer expands lines

This recently amplified line contains 26 basic series of self priming pumps in many modifications and combinations of mountings, fittings and materials. Design changes on basic models include a new cover plate engineered for increased strength and appearance, flanged suction and discharge connections and improved suction check valve.

Included are electric horizontal long-coupled and vertical and horizontal close-coupled models, portable and



stationary engine-driven models and belt-driven models. All of the pumps feature manufacture's free-flow design and "diffuser" method of priming in which the design of the pump itself enables it to prime automatically. All are said to handle a wide range of liquids: clear water, coolants, chemicals solutions, "dry" aromatic fluids, volatile liquids and those containing abrasives. They will pump liquids with viscosities up to 500 ssu.

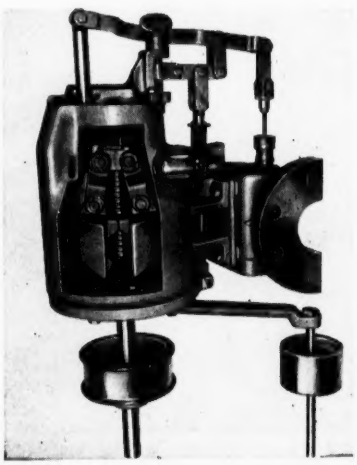
The motor-powered long-coupled (Type EL) models (shown), cover sizes, capacities and head ranges of 1½ to 10 in., 15 to 3500 gpm and 15 to 170 ft. These are standard in cast iron or welded steel, but available in other metals. Many are made with either flanged or screwed suction and discharge connections. Motors are from ½ to 60 hp, mounted with the pump on welded steel frame or on wheel mountings. Many motor-driven models in capacity range from 50 to 250 gpm are available in close-coupled construction.

The entire line is also available with engine drive in low pressure sizes 1½ to 10 in., capacities from 50 to 4000 gpm; high pressure models from 2 to 6 in., capacities 50 to 1000 gpm. Gasoline or Diesel engine powered. Marlow Pumps.

19—THROTTLING GOVERNOR

For steam engines, it controls a wide range of speeds

Governor control of steam engine speeds over ranges of 2 to 1, 4 to 1, or 6 to 1 is said to be possible with the new Type EN throttling governor. With it, the engine speed can be varied either at the governor or from a remote point, manually or automatically. This new governor is described as having totally enclosed construction and self lubri-



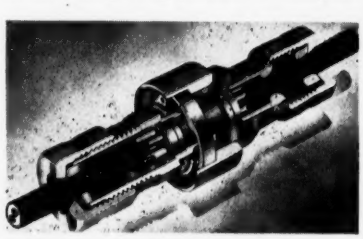
cating mechanism. Ball bearings throughout are designed to assure full sensitivity during the long life of the unit.

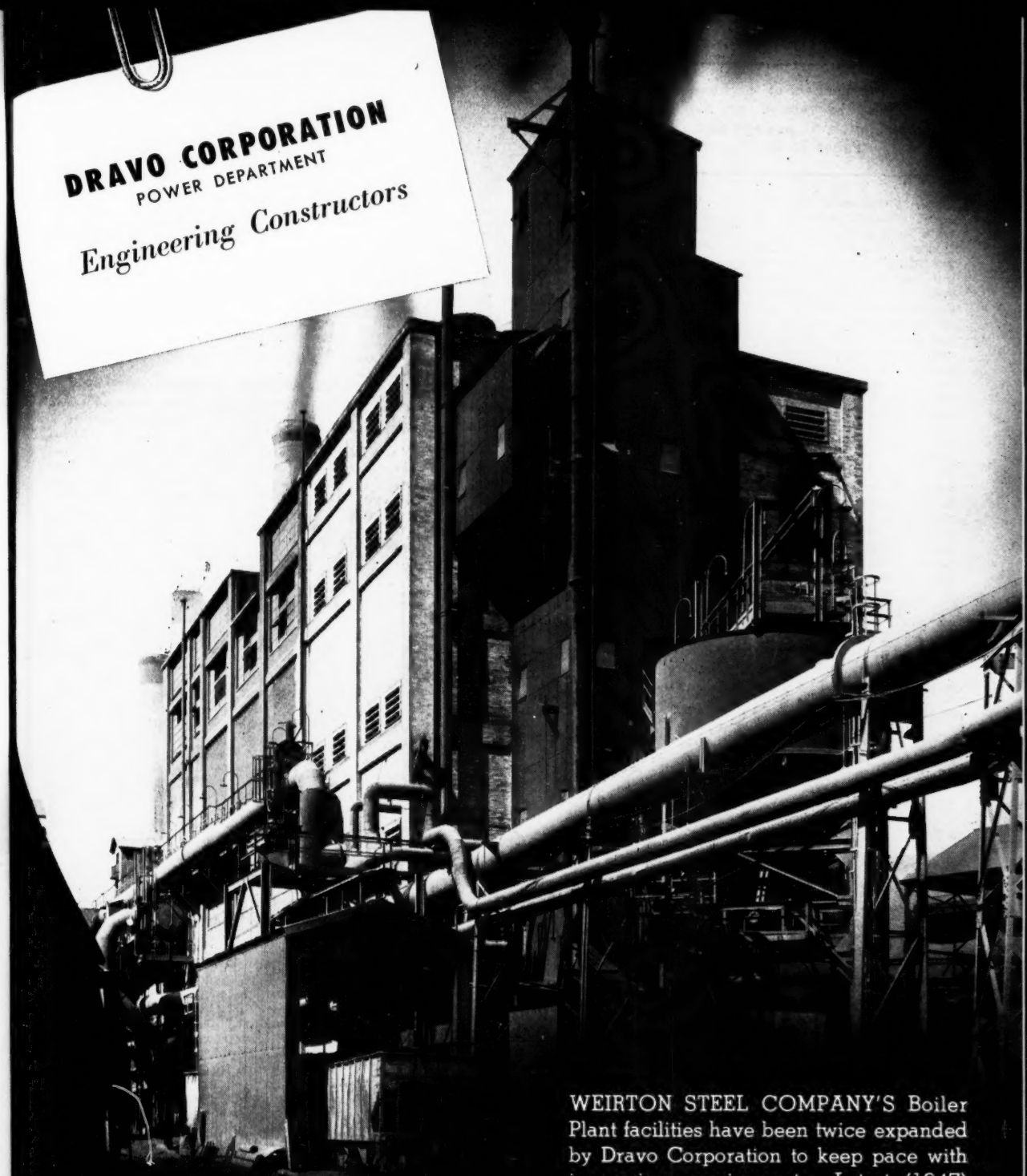
Further features include automatic stop in event of belt failure, interchangeable parts through a wide range of sizes, and ready adaptability to old or new steam engines of either horizontal or vertical design. Troy Engine & Machine Co.

20—ELECTRICAL COUPLING

Waterproof, quick-disconnect type for all-weather and submarine use

Known as the 1600 Series, this coupling is intended for public services and industries requiring an electrical connector that is quick acting, heavy duty, impervious to moisture and capable of withstanding long periods of complete





WEIRTON STEEL COMPANY'S Boiler Plant facilities have been twice expanded by Dravo Corporation to keep pace with increasing requirements. Latest (1947) extension adds another complete unit to the high pressure boiler plant and 325,000 lbs. per hr. to steam output. Dravo-built boiler plants serve companies which produce more than 47% of the nation's steel.

DRAVO
CORPORATION

DRAVO BUILDING, PITTSBURGH 22, PA.

Engineering Constructors of power plants, boiler plants, central stations, compressor stations, water pumping stations—fabricators and erectors of power piping—power and boiler plant equipment.

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immersion under high external pressure without leakage. Submergence tests were conducted successfully with this coupling on U. S. Navy equipment, according to manufacturer, who points out that test results showed that even with external pressure conditions equivalent to 1150 ft of water, no leakage or moisture seepage occurred.

A quarter turn is said to be all that's required to make or break the coupling and no tools are required. A wide selection of standard electrical inserts are available, manufactured to Army-Navy specifications and employing phenolic material of high dielectric qualities. Couplings are provided either with pressure tight cable seals, or are threadded for attachment to conduit, bulkheads or panels. Coupling is manufactured from bronze alloys and available in a wide range or sizes. Other materials, such as aluminum alloy or stainless steel can be supplied. Applications include use in the electronic field; geophysical uses; telephone and coaxial cables, marine use. Roylyn Inc.

21—AIR-POWERED PIPE SAW

Cuts cast iron or steel pipe 12 to 48 in. dia at rate of 2 in. per min

National Pipe Saw uses a high speed steel milling cutter which leaves clean cut milled edges and requires only 85 lb of air pressure for operation, it is reported. Changes in adjustment for different pipe sizes are made by setting guide rollers and altering the two travel-chain lengths. The saw is strapped tight to the pipe by two silent type chains acting as a flexible ring gear to provide for positive feed and automatically compensate for pipe "swells and irregularities." As it cuts it travels around the pipe, making the cut in one complete rotation.

Saw is portable, weighing 265 lb, and can be handled and set up by two men in about 15 min, according to manufacturer. Cuts above ground are made by rolling pipe on skids, while underground cuts require only 14 in. clearance in the ditch. Sealed construction permits cuts to be made under water where ditches are flooded. Described as ideal for cutting gas and petroleum product pipe lines and for precision cutting on large water mains. The E. H. Wachs Co.

22—STEEL WORK BENCH

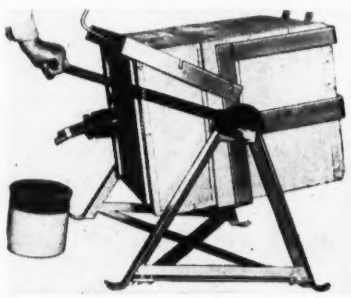
Is streamlined and extra strong for heavy industrial use

This high efficiency work bench is a generous 6 ft long, 34 in. high and 28 in. deep. Small lathes, drill presses, bench grinders and punch presses can be attached and operated wiwth ease on its 12-gage steel top. The legs are sloped back to prevent stumbling; electrical knockouts for double outlets are provided in front of each leg, just below the top; back rail is provided to keep items from rolling off the top, and drawer is mounted on rollers and said to be pilfer-proof; full base to floor keeps dirt from accumulating underneath. Bench may be bolted to floor through concealed holes inside flange of end panel. Standard finish is olive green enamel; other colors optional, including ivory or white at slight extra cost. Aurora Equipment Co.

23—CARBOY TILTER

With safety air vent pouring spout, has ratchet control of position

The Safety Carboy Tilter is intended to provide a safe, fast and convenient method of draining acids and other liquids from carboys of any size. The cradle and supporting base are made of structural steel, all members riveted or welded for strength and durability. The



locking device is designed to permit carboy to be held at any angle for pouring so the whole operation can be done by one man.

The safety air vent pouring spout is provided to insure an even flow of acid without spurts or splashes. It is made of acid resistant rubber and plastic tubing. Flow capacity is 5 gpm. The long handle operates tilter easily and permits operator to remain at a distance from the acid. The tilter can be left in a position just above the flow of acid so it is not necessary to return carboy each time all the way to a pouring position, eliminating waste motion and saving time when a number of small containers are being filled. Costs $34.50. General Scientific Equipment Co.

24—ELECTRICAL TAPE

Provides high dielectric strength, and resistance to abrasion

Made with a plastic backing, the tape —"Scotch" brand electrical tape No. 33—is listed by Underwriters' Laboratories for temperatures as high as 176 F, and it is pointed out that tests show the tape has 125 per cent stretch, excellent aging properties and sufficient toughness to be used on feeder cables for quarry shovels.

Tape is 7 mils thick, has a dielectric strength of more than 7,000 v, adheres to plastic wires, and is described as impervious to moisture and affording

protection against electrolysis and corrosion by oils and acids. Applications include use in junction boxes, motors, outdoor lighting wiring, refrigerator units, underground cables and bus bars. Minnesota Mining and Mfg. Co.

25—MOTOR GENERATOR SETS

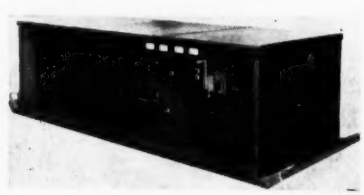
Are packaged units for coal mines, providing d-c power for machines

Designed to meet d-c power requirements for mining coal with new continuous-type machines is this portable 30-kw motor-generator set with auxiliary control switchgear. It is intended to provide an underground power source for machines which combine the operations of cutting, drilling, blasting and loading of coal into a single integrated performance and require more direct current than is presently available in some mines.

Dimensions of the set show compactness and relatively light weight. Under 43 in. high, 7 ft wide and 16 ft long, it weighs approximately 19,000 lb and is suited for use in confined areas of low head room. In effect a "traveling" power center closely following the advance of the mining machine through underground passages, this set will change 2300 v a-c received from heavily insulated cables dropped into the mine through bore holes to 250 v d-c. At intervals of weeks or months, the motor generator set with control and switchgear will be advanced 600 to 1200 ft to permit mining equipment to be moved ahead.

Driven by a 2300-v, 450 hp synchronous motor, the set is built to handle a 25 per cent overload for two hours, a 100 per cent overload for a minute. Through its sectionalized d-c distribution panel it will serve two mining machines and auxiliaries such as shuttle cars and conveyors. Both the set and its control and switchgear assembly are mounted on rigid skid bases in two self-contained "packages" to facilitate moving. This arrangement is also intended to eliminate realigning or grouting-in of mounting base, and to provide protection against rough handling.

Excitation for the synchronous driving motor, designed for full voltage starting with low kva, is taken from generator circuit. The d-c generator is compound wound, interpole design, self-excited. Each machine, equipped with its own anti-friction bearings, is flexibly coupled and mounted on a rigid base. Reliance Electric & Engineering Co.



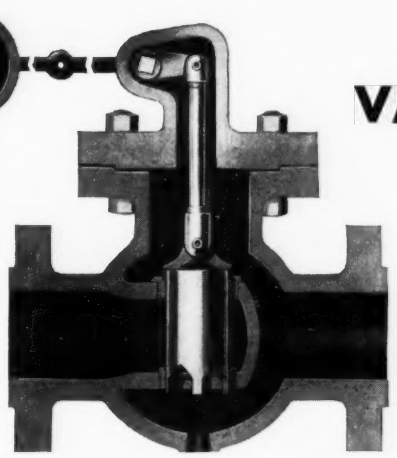
COPES BALANCED VALVES

Wherever you use float valves, avoid losing any of your operating force in the stuffing box. Insist on low and constant valve stem friction.

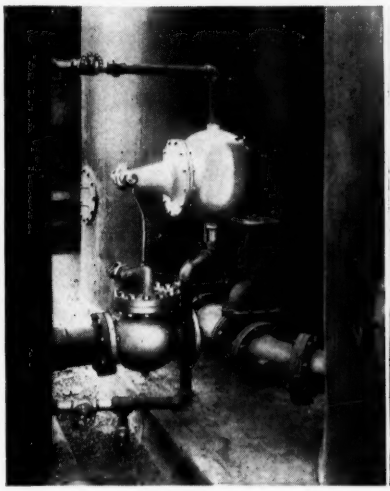
Make sure of instant, accurate response to your actuating force—no matter what your flows and pressures—by demanding close control of the unbalanced forces found in every valve.

Provide for minimum pressure losses at high flows by requiring your valve ports to be accurately designed for the conditions you specify.

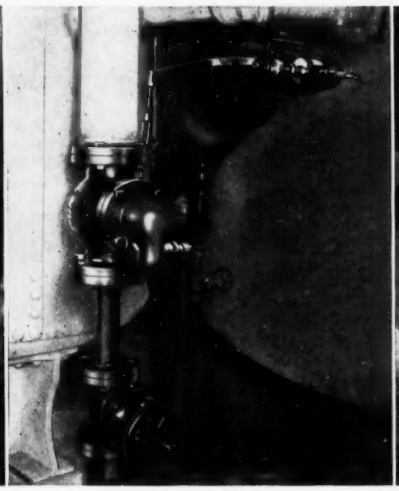
In other words—insist on COPES Balanced Valves. They offer all these important advantages —plus long service life with minimum maintenance. Write in detail about your needs.



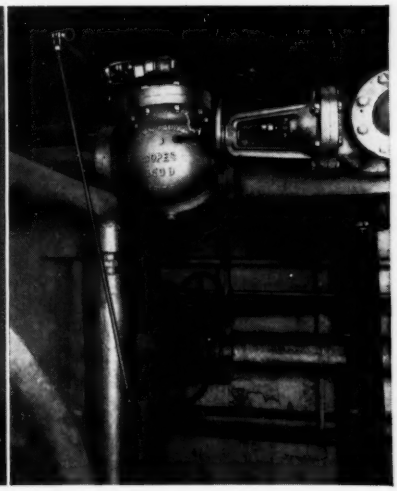
With the COPES Type BI Valve, rotating stem means low stuffing box friction. Accurate balance assures quick and accurate response. Exact capacity you need is provided.



Float-operated COPES Type BI Valve controls flow of condensate from flash tank to storage tank.



Flow of blow-down water from a flash tank is controlled by this float-operated COPES Valve.



Water level in a deaerating heater is controlled by this float-operated COPES Balanced Valve.

NORTHERN EQUIPMENT COMPANY
792 GROVE DRIVE, ERIE, PA.

BRANCH PLANTS: Canada, England, France, Italy and Austria. *Representatives everywhere.*

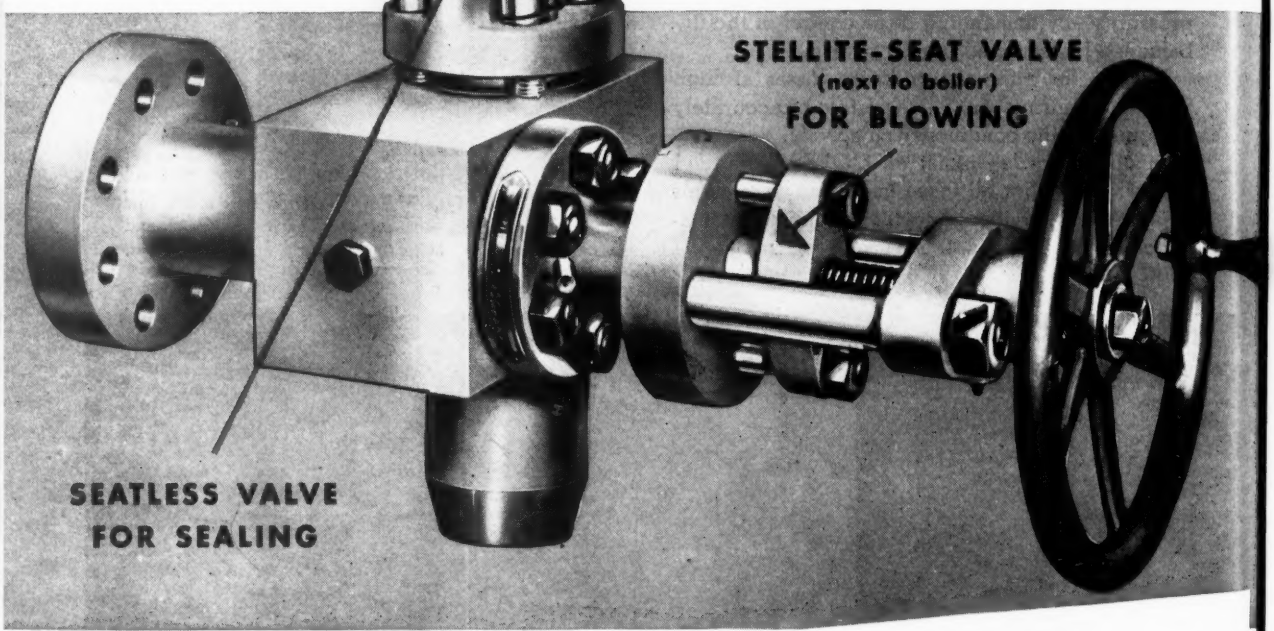
Bulletin 443-B gives condensed data on all major COPES products. Write for a copy—your letterhead, please. Keep it for reference.

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

UNIT TANDEM



YARWAY'S Answer to High Pressure Blow-Down Requirements

As pressures increase, so does the demand for dependable blow-off valves to meet these needs.

The Unit Tandem is Yarway's answer . . . proved by hundreds of successful high pressure installations in leading utilities and industrial plants.

This blow-off valve, combines the worth-while improvements and advances both in metallurgy and mechanical design.

Unit Tandems are built for pressures to 2500 psi.

Inside (next to boiler) blowing valve is the Yarway Stellite-Seat valve.

Outside sealing valve is the famous Yarway Seatless design which has no seat to score, wear and leak. This valve is always opened first and closed last, maintaining a tight seal at all times.

Write for Yarway Bulletin B-432 for complete description of this Unit Tandem. For lower pressures ask for Bulletin B-424.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY BLOW-OFF VALVES

LETTERS TO THE EDITORS

WATER LEVEL

RELATIVE to the different opinions expressed by Messrs. Browning, Persinger and Carroll on what to do if the boiler water level is out of sight, I would like to call attention to a statement on page 345 of *Steam*, 36th Edition, published by The Babcock & Wilson Co. in 1923. The fact that this was written 26 years ago does not alter its authoritativeness, since the basic principles of correct boiler operation have not changed, regardless of changes or improvements in boiler design.

The statement in *Steam* reads: "In a distinct case of low water, resulting either from carelessness or unforeseen operating conditions, the object is to extinguish the fire in the quickest possible manner. The fuel supply should be shut off, the air supply to the fuel closed, and, where practicable, the fires should be covered with wet ashes, keeping the grates in motion. Under certain conditions, it is feasible to put out the fire with a heavy stream of high pressure water from a fire hose, and where this method can be followed, it should be used. Such a method is dangerous, to an extent, but is justifiable, particularly in the case of large units, from the stand-point of saving the boiler. The feed valve should be closed, and under no circumstances should water be fed to the boiler. The safety valves should not be opened nor the opening of the main steam valve be changed.

"In general nothing should be done that would tend to alter the stresses acting on the boiler."

Thus we find that there are five main points which should be observed, the first three as quickly as possible:

1. Cut off fuel and air supply.
2. Extinguish fire.
3. Close feed water valve.
4. Don't open safety valves.
5. Don't disturb setting of main steam valve.

Nothing is mentioned about opening superheater vents and, in conformity with the admonition found in the last sentence of the B & W statement, one can readily see why. Opening either the main steam valve or the superheater vents would tend to alter the stresses acting on the boiler.

In over 30 years experience with steam boiler practice, I have never found any one who said that trouble would result if the above points were followed. In many cases I have seen operators who did exactly as outlined. In a few cases, I have found operators who followed four of the five points but did not close the feedwater valve immediately.

In actual cases which I observed, the probability was that the water level was not very far below the gage glass and, therefore, no damage was caused by allowing water to enter the boiler. If the boiler had been almost dry and water then allowed to enter at the same rate or that rate increased by opening the valve wider in a frantic effort to cause water to show in the glass, strains might have been produced which would have caused damage to the boiler.

Boiler operators who follow the above rules will find them safe guards against trouble.

Dallas, Texas — J. R. DARNELL

BOUQUETS AND BRICKBATS

MAY I open by complimenting you on your Q & A Department and the method of handling it? It seems to me that a large number of practical engineers in the field should benefit immensely from that department, because the problems brought up are approached from a practical rather than a theoretical or rigorous point of view.

Toledo, Ohio — J. W. BRAITHWAITE

* * *

THANK YOU for your fine treatment of my answer to the..... problem. It might interest you to know that it aroused considerable comment and discussion among engineers around this town, also in my company and in my local chapter of NAPE. My chief complimented me on it. I feel all puffed up.

A. H. M.

* * *

I HAVE JUST received your letter of April 22 with which you sent several copies of the Ringelmann smoke chart. These delighted me, for they will prove very useful in my business.

Czechoslovakia — K. W.

Editor's Note: — These were the small Ringelmann charts described in POWER GENERATION, April 1948, page 79.

* * *

THE JOHN CRERAR LIBRARY owes you warm thanks for the complimentary words that appear under the *Engineers' Preview* in the March issue of POWER GENERATION. We have had quite a number of inquiries from both coasts and in between.

We are very much aware, of course, that one of our primary problems in developing our Research Information Service is to increase the knowledge of our facilities and services among the companies and individual engineers who have research and development problems. Your editorial comment made an important contribution to our program in this respect.

HERMAN H. HENKLE
Librarian

The John Crerar Library
Chicago

* * *

What! No brickbats to go with the bouquets? Well, don't worry; we'll have plenty of them as soon as the next issue is off the press—and we'll pass along those that will not violate post-office regulations.

QUEER QUIRKS

Gentlemen of this gay, though sometimes hair-raising, profession who have reached maturity should be able to write interesting volumes about their strange experiences in dealing with perverse equipment. A lot of strange things happen in the course of an engineer's life and these should be recorded for the benefit of those who read and run—machinery. All of us have queer and seemingly occult things happen, figure a way out of the difficulty, and caper away rejoicing without a single thought about the other fellow who may face a like situation and not have our superior brain power to figure a way out.

Trouble columns, questions, letters from contributors and readers in trade and technical magazines are a great boon to operating men and help them along the road to good engineering. The sections that deal with practical operation (and that reminds me, where is the Practical Engineer Section?) and everyday trouble shooting will show more thumbprints that the more highly technical articles every time. All the sheepskins and Bs degrees in America won't tide you over those big and little emergencies that make up the engineer's daily regular diet; he has to do his own thinking and be right on his toes in doing it.

I have found it good practice to cut out all such pertinent hints and kinks, answers to questions, etc, paste them in a good big album (actually, I have three) index the material as seems best, so that you can readily find the other fellow's answer as problems occur and recur in different forms of the same thing.

A case happened not long ago right in line with a magazine article on internal tank-wastage. Hot water and domestic heating storage tanks showed signs of leakage, some in rather weird spots, after only four to eight years of life. They were

(Continued on page 59)

These Tables Speed Up Pipe Sizing—Steam

All on these two pages for Power Engineer's Notebook or File

Table I. Values of M_1, Flow Multipliers for various steam pressures and temperatures

Values of M_1, Multiplier for Steam Pressure and Temperature

Pressure		Saturation		Flow, lb per hr, at Various Temperatures, Deg F										
		Temp. Deg F	Flow	200	300	400	500	600	700	800	900	1000	1100	1200
In. Hg Vacuum	29	76.5	464	404	376									
	28	99.6	667	601	551									
	25	133.2	1065	1000	918									
	20	161.1	1510	1450	1305									
	15	178.9	1840	1805	1665									
	10	192.2	2110	2100	1940									
	5	203.6	2370		2190	2030								
PRESSURE, PSI GAGE	0	212.0	2580		2400	2230	2080	1960	1860	1775	1685	1610		
	5	227.2	2990		2790	2600	2440	2280	2170	2070	1970	1885		
	10	239.4	3310		3140	2930	2750	2580	2450	2330	2230	2130		
	15	249.7	3625		3480	3240	3030	2860	2700	2580	2460	2360		
	20	258.4	3900		3780	3510	3300	3100	2940	2800	2670	2550		
	30	274.0	4400		4300	4020	3760	3540	3370	3210	3060	2920		
	40	286.7	4850		4790	4460	4170	3940	3740	3560	3400	3260		
	60	307.3	5640			5250	4910	4630	4410	4200	4010	3850		
	80	324.0	6310			5960	5560	5250	4980	4750	4540	4360		
	100	337.9	6920			6580	6150	5800	5500	5250	5030	4820		
	120	350.0	7470			7170	6700	6310	6000	5700	5460	5230		
	140	360.9	7990			7730	7200	6790	6440	6150	5870	5630		
	160	370.6	8480			8270	7680	7240	6860	6530	6250	6000		
	180	379.6	8930			8770	8140	7650	7260	6920	6610	6310		
	200	387.8	9370			9260	8560	8050	7640	7290	6960	6660		
	250	406.0	10390				9590	9000	8540	8120	7770	7440		
	300	421.8	11300				10560	9890	9340	8880	8500	8140		
	350	435.7	12170				11470	10700	10100	9600	9180	8790		
	400	448.2	12990				12340	11480	10810	10280	9800	9400		
	500	470.0	14470				14000	12900	12120	11500	10980	10520		
	600	488.8	15840				15640	14240	13370	12620	12040	11540	11090	10700
	700	505.4	17130					15540	14490	13690	13040	12500	12000	11570
	800	520.3	18400					16800	15610	14700	13950	13380	12830	12390
	900	533.9	19620					18060	16700	15650	14880	14210	13640	13140
	1000	546.3	20780					19350	17710	16590	15720	15000	14400	13890
	1200	568.7	23020					21970	19700	18370	17330	16510	15860	15250
	1400	588.4	25250					24630	21650	20000	18870	17940	17150	16500
	1600	606.1	27450						23600	21650	20300	19250	18420	17670
	1800	622.1	29700						25600	23220	21700	20550	19620	18850
	2000	636.8	32070						27620	24850	23080	21750	20780	19900
	2500	669.0	38350						33850	28850	26350	24700	23480	22450
	3000	695.9	47900						45000	32800	29500	27450	25970	24750

Instructions for Use and Examples

Relations of the quantities shown in the tables are given by the multipliers:

Total flow in lb per hr $= M_1 \times M_2 \times M_3$

where M_1 = Multiplier for flow in lb per hr

M_2 = Multiplier for pressure drop in psi per 100 ft of pipe

M_3 = Multiplier for various pipe sizes

Pressure drop from Table II — $M_2 = \dfrac{\text{Flow}}{M_1 \times M_3}$

Size of pipe from Table III — $M_3 = \dfrac{\text{Flow}}{M_1 \times M_2}$

Example: — What size pipe is required to pass 100,000 lb of steam per hr at 300 psig, 500 F total steam temperature; total length of pipe 385 ft; total allowable pressure drop 10 psi?

Solution: — Pressure drop per 100 ft $= 10 \div 3.85 = 2.6$; corresponding $M_2 = 1.630$; $M_3 = \dfrac{100{,}000}{10{,}560 \times 1.630} = 5.8$

In M_3 table, this is greater than the value 2.91 for 6-in. Schedule 40 pipe; close to value 6.0 for 8-in pipe.

Clearly, therefore, 8-in. pipe would be used.

Suppose you started by assuming 6-in. pipe would do it, then, with 6-in. pipe, $M_3 = 2.91$ and M_2 would be $100{,}000 \div (10{,}560 \times 2.91) = 3.25$. This would correspond closely to 10 psi per 100 ft pressure drop or $10 \times 3.85 = 38.5$ total pressure drop—too much, or, with 10-in pipe, $M_3 = 10.9$; $M_2 = 100{,}000 \div (10{,}560 \times 10.9) = 0.87$. This corresponds to 0.766 psi pressure drop per 100 ft or $0.766 \times 3.85 = 2.95$ psi total—far below allowable, hence pipe much bigger than necessary.

IMPORTANT NOTE: These tables are for total length of pipe alone. If it includes fittings, equivalent lengths of pipe for fittings are shown in a Crane Co. chart on facing page; published large size in ***Power Plant Engineering,*** October 1946, page 112; included in Crane Catalog No. 41, Supplement 6; also in De Laval Engineering Handbook, page G-74, and in other standard handbooks.

If given length of pipe contains valves and fittings, figure piping first, then add equivalent lengths of fittings and recalculate as above; or calculate pressure drop through fittings, taking equivalents from chart, and subtract pressure drop of fittings from total allowable pressure drop, remainder being allowable drop through piping alone.

and Water Flow, Pressure Drop, Pipe Size

By A. B. STICKNEY, The Rust Engineering Co.

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Table II. Values of M_2, Multipliers for various pressure drops per 100 ft of pipe length

Values of M_2 for small Δp's		Values of M_2, Multiplier for Various Pressure Drops, Δp Δp = psi per 100 Ft of Pipe									
Δp	M_2	$\downarrow \frac{\Delta p}{+} \rightarrow$	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.01	0.0825	0	0.000	0.299	0.418	0.533	0.620	0.696	0.768	0.833	0.893	0.948
0.02	0.122	1	1.000	1.043	1.096	1.141	1.185	1.228	1.269	1.309	1.348	1.336
0.03	0.153	2	1.423	1.460	1.495	1.530	1.564	1.597	1.630	1.661	1.693	1.723
0.04	0.180	3	1.754	1.783	1.812	1.841	1.869	1.897	1.925	1.952	1.979	2.005
0.05	0.206	4	2.031	2.057	2.082	2.107	2.132	2.156	2.181	2.205	2.228	2.252
0.06	0.226	5	2.275	2.298	2.321	2.344	2.366	2.389	2.411	2.432	2.454	2.476
0.07	0.246	6	2.497	2.518	2.539	2.560	2.581	2.602	2.622	2.642	2.662	2.682
0.08	0.264	7	2.702	2.721	2.741	2.760	2.779	2.798	2.817	2.836	2.854	2.873
0.09	0.282	8	2.891	2.909	2.928	2.945	2.963	2.981	2.998	3.016	3.033	3.050
		9	3.068	3.084	3.101	3.118	3.135	3.151	3.168	3.184	3.200	3.217
		10	3.233									

Table III. Values of M_3, Multipliers for various sizes of pipe

Values of M_3, Multiplier for Various Sizes of Pipe				
Nominal Size Inches	ASA-B36.10 Schedule No.			
	10	40	80	160
1/8		0.00071	0.00039	
1/4		0.00160	0.00099	
3/8		0.0037	0.00245	
1/2		0.0069	0.0049	0.0032
3/4		0.0148	0.0113	0.0067
1		0.0280	0.0221	0.0144
1 1/4		0.058	0.047	0.036
1 1/2		0.087	0.073	0.054
2		0.171	0.144	0.100
2 1/2		0.280	0.231	0.183
3		0.48	0.42	0.32
3 1/2		0.71	0.62	
4		1.00	0.86	0.66
5		1.79	1.58	1.18
6		2.91	2.52	1.91
8		6.0	5.3	3.9
10		10.9	9.5	7.0
12		17.2	15.0	10.9
14	23.8	21.8	19.2	14.3
16	35.0	31.0	27.5	20.7
18	47.0	42.0	37.0	28.2
20	63.0	55.0	49.0	37.0
24	102.0	90.0	80.0	60.0
30	182.0			

Table IV. Values of M_1, for water at various temperatures

M_1 for water	
Temp. Deg F	M_1
100	104,000
200	105,500
300	104,300
400	101,700
500	97,400
600	90,500
700	72,300

Resistance of Valves and Fittings to Flow of Fluids

(Chart Courtesy Crane Co.)

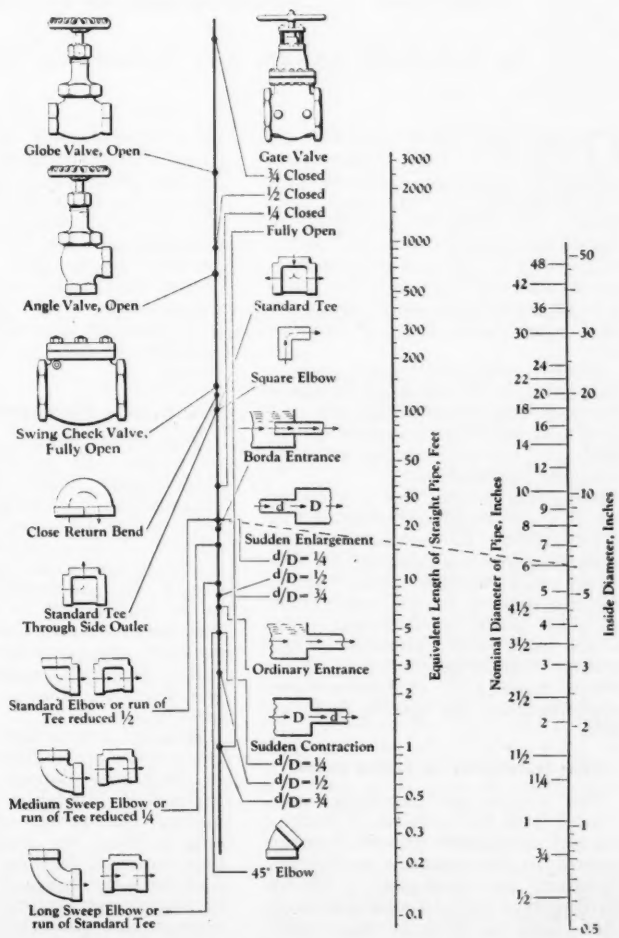


Fig. 1. View of complete installation of overfire jet smoke control, fabricated on job to fit special conditions, showing nozzles, header and, at right, blower and air intake filter

Fig. 2. One of the overfire air nozzles of the system, made of 4-in. standard pipe reduced in two steps to 2½ in., designed as per instructions given in BCR Technical Report No. VII

We Tailored Our Smoke Control to Fit

Successful tailor-made overfire jet smoke control, costing $1200 complete with controls, applied to 329-hp boiler fired by multiple-retort underfeed stoker . . . Overfire air system designed by following BCR Technical Report No. VII, fabricated by plant maintenance department . . . Space limitations prevented installation of purchased package units . . . Details of nozzles, headers, valves, blower . . . Controlled automatically from photo-electric relay and smoke density meter

By **J. RICHARD MANIER**, Junior Engineer, Brown-Lipe-Chapin Division, General Motors Corp.

OBJECTIONABLE SMOKE and soot from boiler plants are caused by incomplete combustion of volatile matter in bituminous coal. This is due either to lack of air in the combustion chamber or to the inability of the air and volatile matter to mix properly before the products of combustion pass out of the high temperature zone of the fire box.

Proper correction in many cases is the admission of additional air above the fuel bed, through nozzles that give turbulence and assure proper mixing of the air with the gases, to complete combustion.

Many plants can use a package overfire air supply unit consisting of a centrifugal blower, manifold, and a series of nozzles designed for different sized blowers, which can be directly applied to the boiler. But, in older power houses and those where space is at a premium or operating conditions unusual, it is often necessary to tailor-make equipment for the specific installation.

Pilot Installation on 329-hp Boiler

The author was recently confronted with the problem of designing and installing a system of smoke control. In this instance, a pilot installation was made on a 329-hp Stirling-type boiler manufactured in 1920. Coal is fired to this boiler by a forced-draft multiple-retort underfeed stoker, as in Fig. 5. During the peak season this boiler is operated at loads exceeding 200 per cent of rated capacity. It is often necessary to work the fires to allow primary air to pass through the deeper fuel beds, and this causes excessive smoking. The problem, then, resolved into one of installing overfire air jets to eliminate the smoke.

How Overfire Air System was Designed

The power house was designed to house the equipment now in operation. Space is limited and examination indicated that standard overfire air units were not applicable. It was decided to design a suitable set-up and use the facilities of the maintenance department in its fabrication. This also offered the opportunity to compare costs of package and plant-fabricated units and to do some research on the subject. Figure 1 shows the completed installation.

Detailed instructions for computing overfire air jet data are included in Technical Report No. VII by Richard B. Engdahl and William S. Major.* The power engineer needs only to know the depth of penetration required, heating value of the coal he uses, burning rate of coal in pounds per square foot of grate area per hour, and the density of the smoke present, as determined by a Ringelmann Chart.

This BCR report enables the engineer to compute the diameter of the air nozzles required, the blower static pressure required, the capacity of the blower in cfm, the diameter of the manifold so as to remain below a critical velocity of 2000 fpm, and the spacing of the nozzles in the furnace wall. Since this application was on a multiple-retort underfeed stoker, the nozzles were spaced over the retorts.

How Nozzles Were Made

Design of the nozzles was the next undertaking. Sufficient allowance was made in their length for flanging outside the furnace wall. The main nozzle body was made from 4 in. standard pipe, which was reduced in two stages to 2½ in. diameter, the discharge diameter as determined from application of data in Report No. VII. The nozzle tips were rolled and welded from a heat-resistant alloy steel to minimize maintenance. The completed nozzle is shown in Fig. 2.

* *Technical Report No. VII*, Application of Overfire Jets to Prevent Smoke from Stationary Plants, by R. B. Engdahl and Wm. S. Major; published by Bituminous Coal Research, Inc., 912 Oliver Bldg., Pittsburgh 22, Penna.; price 25 cents. See also: Where to Put Overfire Jets, by Wm. S. Major, POWER GENERATION, March, 1948; and How to Construct Overfire Jets for Your Plant, *Ibid*, April, 1948.

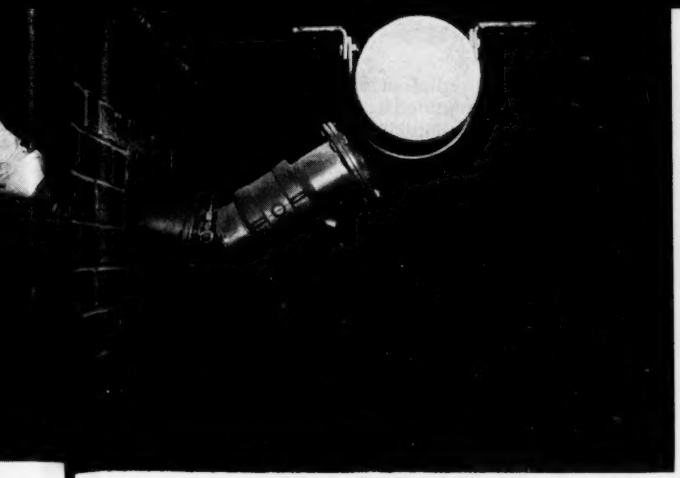


Fig. 3. Detail of connection of flanged nipple to manifold. Space too small for bolting and unbolting flanges, so flanges were cut from ¼-in boiler plate and everything welded

Fig. 4. Close-up detail of butterfly air valve, one placed in each connection between header and nozzle, to control penetration of jet as required by conditions

Before any connection could be devised between the header and the nozzles, it was necessary to permanently locate the header. Clearances over ashpit doors and from the fly ash chutes, also location of the centrifugal blower, were factors considered in this design. Following a cut-and-try procedure, the header was finally located as in the illustrations.

In connecting header and nozzles, it was deemed advisable to allow sufficient clearance for removal of the individual nozzles without disturbing any of the remaining equipment. This would give flexibility in inspection and replacement of nozzles. Butterfly air control valves were placed in each of these sections.

Header Details

The complete connection, Fig. 3, shows a flanged nipple welded to the manifold. The elbow connection following was made to meet the angle of the nozzle extending from the bridge wall, and the butterfly valves were installed in the longer legs of the elbows. Taps were also provided for checking static pressures.

Standard flanges were not used because of minimum space requirements for bolting and unbolting the flanges. They were cut from ¼ in. boiler plate and then welded to the nozzles, elbows, and nipples.

Requirements of this installation called for a 6 in. header. The holes where the nipples were to be connected were cut with the aid of a template, and the nipples were welded in place. The end away from the blower was blanked off with ¼ in. boiler plate and the other end screwed into the flanged connection coming from the blower discharge. The header was fastened in position by straps welded to I beams in the overhead. This strap is shown clearly in Fig. 3.

The bridge wall was chosen as a point of entry because the front of the boiler was obstructed by the hopper. First step in installing was to make holes over the retorts, using a pneumatic drill. The nozzles were then temporarily placed at the predetermined angle and fire clay tamped around them to form a mold conforming to the shape of the nozzle. This holds them securely in proper location and allows for their removal at any time, without fear of altering their alignment.

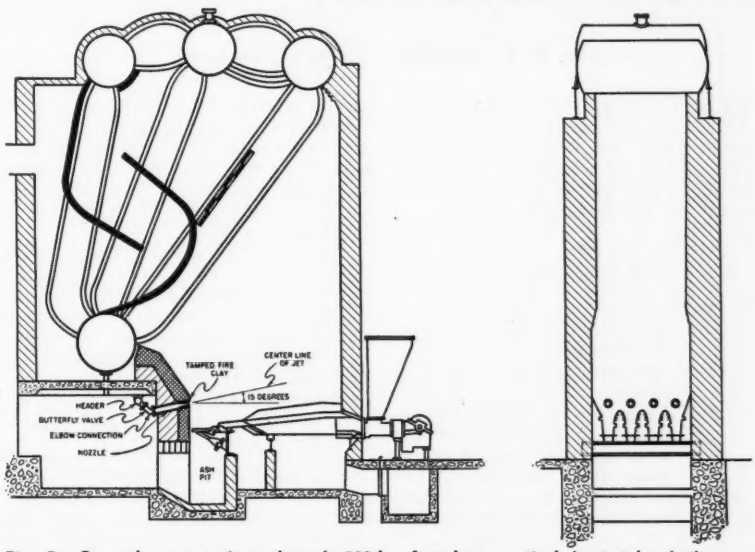


Fig. 5. General cross-sections through 329-hp four-drum vertical bent tube boiler on which tailor-made smoke control was installed to supply overfire air for multiple-retort underfeed stoker

Blower, Air Filter, Controls

After the header was put in place and connections made between the header and nozzles, the setting of the blower unit remained. The blower was supported on a standard to bring the discharge to manifold level, Figs. 1 and 3. It is advisable to filter entering air to keep dirt and dust out of the piping and nozzles, hence an adapter was made to allow the use of a standard 20 in. by 20 in. fiberglass filter on the blower intake, as in Fig. 1.

The final problem was that of control. Although automatic control is the only efficient method, manual control was first used until further investigations were made. At this writing, automatic control in the form of a photoelectric relay is on order. It is planned to connect the relay to the coil of the blower motor starter through a timer. The unit will be adjusted using a smoke density meter, which is included in the control package. Control will be provided for each boiler.

To insure against the lenses of the control becoming dirty and thus reducing its effectiveness, the connections between the light source and relay to the breeching will be vented. The draft in the breeching will draw air in from the outside to protect the lenses from soot.

Results Obtained

When the insulation was ready for operation, tests were conducted to check its effectiveness. Depth of penetration required to cover the

smoking areas was adjusted by use of the butterfly air valves, Fig. 4. Orsat and visual tests were made to study the degree to which the jets were improving combustion and eliminating the smoke. The results were satisfactory in all respects and the installation was approved by the city inspector. Since all the boilers in the power house have not yet been equipped, no accurate check of operating efficiencies has yet been made. With more complete combustion, there should be some increases.

A comparison showed that, in this instance, the cost of a plant-fabricated unit was less than if a special package unit had been used. The cost per boiler, including fabrication, installation, blower, and controls, amounted to approximately $1200.

Completed installation, Fig. 1, is unobtrusive to the eye and does the job for which it was designed. It will bring about a better relationship between the plant and the citizens of the surrounding territory and will help to make a cleaner, healthier community.

FIRING

Calculate Your Excess Air Percentages More Accurately

By J. R. DARNELL, Consulting Engineer

RECENTLY the author came across a clipping from the September 1939 issue of *Power Plant Engineering* in which the following formula was given for calculating excess air for given CO_2 values:

$$\text{Excess Air} = \frac{20.9}{CO_2\,(R+3)} - \frac{R+2.37}{R+3}$$

where,

CO_2 = per cent CO_2 by volume in dry flue gas.

R = fuel ratio for fuels as follows:

Anthracite 50-25; Semi-anthracite 25-20; Semi-bituminous 20-16; Bituminous 16-12; Lignite 12-9.

It is unfortunate that from time to time such indefinite formulas crop out in our technical literature. How many power plant operators, from a rookie fireman up to the Chief himself, have the necessary knowledge to decide whether R should be 50 or 25 for anthracite or 16 or 12 for bituminous coals?

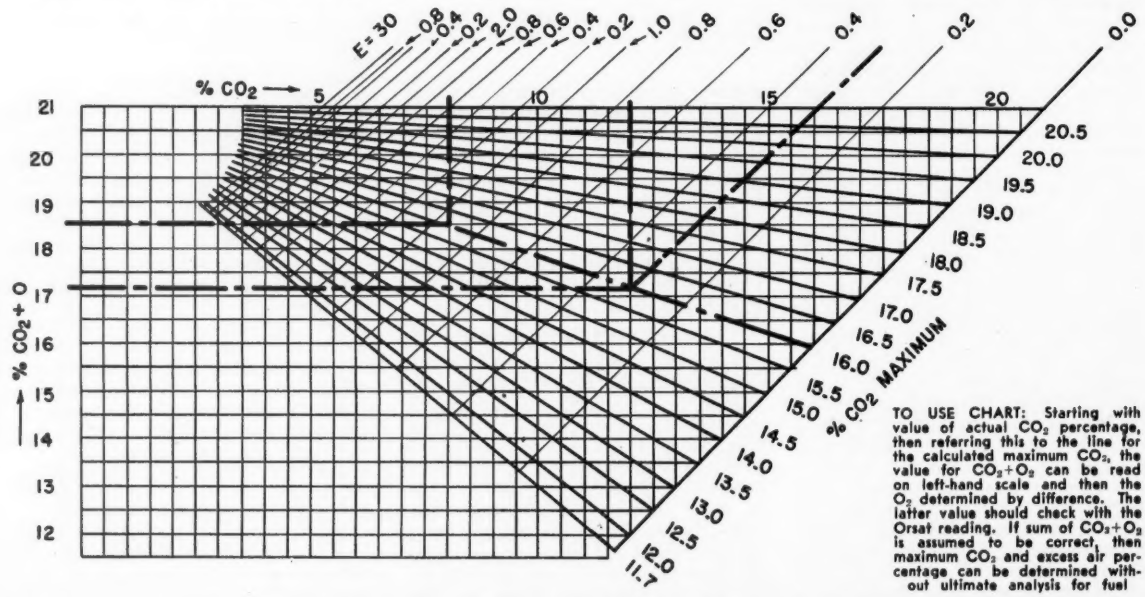
Since determination of the correct percentage of excess air for a given CO_2 value depends on the maximum theoretical CO_2 possible for the particular fuel being burned, we must have a fairly accurate analysis of that fuel, in order to determine such maximum value. This is particularly true as regards the ultimate carbon and hydrogen.

What Is the Fuel Ratio?

In the above formula, which insufficiently describes R as the "fuel ratio," the respective ratios for the various fuels actually are supposed to indicate the range of values for the ratios of C to H or carbon to hydrogen, when referred to moisture-and-ash-free basis. Most industrial grades of anthracite seldom have ratios exceeding 25 to 1. A value of 50 to 1 would be exceptional. One authority has divided the various classes of coals into 12 groups, thus:

Class	Group	Ratio C/H
Anthracite	1	Above 30
Anthracite	2	30-28
Anthracite	3	28-26
Semi-Anthracite	4	26-23
Semi-Bituminous	5	23-30
Bituminous	6	20-17
Bituminous	7	17-14
Bituminous	8	14-12
Bituminous	9	12-11
Lignite	10	11-9
Peat	11	9
Wood	12	7

Since it is obvious that one must have ultimate analysis of these various classes of coals in order to ar-



TO USE CHART: Starting with value of actual CO_2 percentage, then referring this to the line for the calculated maximum CO_2, the value for CO_2+O_2 can be read on left-hand scale and then the O_2 determined by difference. The latter value should check with the Orsat reading. If sum of CO_2+O_2 is assumed to be correct, then maximum CO_2 and excess air percentage can be determined without ultimate analysis for fuel

This diagram provides quick, easy method of checking flue gas analysis if combustion is complete. (From Boiler Fireman's Handbook, by J. R. Darnell; Technical Publishing Co.)

rive at these rather indefinite ratios, why use any formula based on such approximate values?

A Formula to Give Greater Accuracy

When an ultimate analysis is available, the following formula will give positive values for the maximum theoretical CO_2 for any fuel:

$$M = \frac{20.9}{1 + \frac{2.38\,[H-(O\div 8)]}{C+0.37\,S}}$$

where M is CO_2 maximum and C, H, O and S are the percentages respectively of carbon, hydrogen, oxygen and sulfur in the ultimate analysis, as fired.

After calculating CO_2 max., the percentage of excess of air can be determined by use of the following formula:

$$E = \frac{(M-k)\ 0.791}{k\ (100-M)}$$

Where E is percentage excess air, M and k are percentages respectively for maximum and actual CO_2.

If no ultimate analysis is available, any operator can calculate CO_2 max. if he is reasonably sure of the correct oxygen percentage as determined by flue gas analysis. In such case the maximum CO_2 can be calculated by the following formula:

$$M = \frac{20.9\,k}{20.9 - O_2}$$

Typical Example

Going back to the original indefinite formula for excess air, supposing we are burning Eastern bituminous coal but do not have any ultimate analysis and arbitrarily assume that R = 16 and the actual CO_2 is 12.5 per cent. Then,

$$\text{Excess Air} = \frac{20.9 \times 16.0}{12.5\,(16+3)} - \frac{16 + 2.37}{16+3}$$

$$= 44.4 \text{ per cent}$$

Now let us compare the foregoing percentage of excess air with a value calculated from an ultimate analysis:

Carbon	79.90
Hydrogen	4.85
Oxygen	6.75
Nitrogen	1.30
Sulphur	0.69
Ash	6.50
	100.00

Using these values we obtain 18.7 per cent CO_2 as the maximum theoretical. If our actual CO_2 is 12.5 per cent, the excess air then will be:

$$E = \frac{(18.7-12.5)\ 0.791}{12.5\ (100-18.7)}$$

$$= 48.3 \text{ per cent}$$

This clearly shows the fallacy of attempting to use approximate fuel ratio values.

In the author's recently published book, The Boiler Fireman's Handbook (Technical Publishing Co.) chapters of which originally appeared serially in *Power Plant Engineering*, Chapter IV, Interpreting Flue Gas Analysis and Chapter VII, Boiler Efficiency Calculated From Flue Gas Analysis and Temperature, explain how to calculate excess air in cases where combustion is complete and also where CO and unburned hydrocarbons may be present in the flue gases.

LETTERS TO THE EDITORS

(Continued from page 53)

opened and inspected. Certain areas were eroded in regular paths, indicating flow friction by contents, though not sufficient to cause leakage. Others had only a few casual pitted spots, in depth to a third of the shell thickness. The higher, hotter areas were deeply pocked, in places more than halfway through and even completely through the curved shell. The old navy trick of anchoring zinc blocks inside had been tried, I can't say how consistently, (reputedly zinc prevents electrolysis) but in this case zinc was zunc. The tanks were essential to daily operation, and it was decided to spend some currency in solving the mystery of their short merry life. Surfaces were sandblasted down severely, and a coating of zinc sweated on. Little improvement. Lead was tried in about the same way—no better. The tanks could have been replaced new at less cost, but this expense was for research purposes.

One old engineer suggested Portland cement! A dollar's worth mixed with H_2O, and it worked. Applied with an ordinary whitewash brush, reputedly it is still there and working fine. One tip . . . surfaces must be continually wet during application or the goo will not stick uniformly, should really never dry during its lifetime; it might crack and allow attack on the protected metal as before. Inherent alkalinity of the cement is said to neutralize acidity, and for keeps. So far there is no valid reason to challenge any claims for this dollar treatment.

Toronto, Canada — A. E. RICHARDS

PIPING BONERS

IN A CERTAIN CITY, the utility company that supplies district steam to the downtown section is said to follow a policy of training its own mechanics. Under this plan, usually, instead of hiring trained mechanics, untrained men are employed and are then indoctrinated in the methods used by the company. If there is any doubt that this is not a wise plan, the following incidents may be cited, all relating to one of the utility's customers—a large hotel.

On one occasion, pipe fitters of the utility undertook to install orifice connections for a steam flow meter in a 6-in. steam line inside the hotel. After removing a section of the line, it was found upon reassembly that the ends failed to line up by several inches. Noting this, the men applied a torch to one section of the pipe in order to heat it for bending, so as to overcome the discrepancy.

While they were thus engaged, the hotel's pipe fitter happened along and noted what was being done. After asking why it was necessary for them to bend a line that had previously fitted, he walked over and pulled on the other section of the line, which slipped back through the wall, through which it had sprung when disconnected, and lined up once again with the pipe being heated.

Another almost identical incident occurred during the connection of a new customer's line to the utility's main out in the street bed. The hotel had been notified of the necessity for shutting off the steam supply temporarily while the connection was being made, and the chief engineer had warned the utility's men of the necessity for speed, because it was winter and the building would be without heat.

As the deadline neared, the engineer walked across the street to see if the job was nearly completed. He was astonished upon arrival to learn that the men were just beginning to weld a short jumper connection between the utility's main and the customer's line, to make up a deficiency in the length of the customer's supply connection. This, of course, would consume considerable extra time and the hotel was already growing cold rapidly.

When the engineer asked why the connection was short, someone pulled on the pipe and it slid out through the wall of the building and easily reached the company's main. It developed that the utility's day crew had installed the stub line with a valve inside the building wall and had not shoved the pipe far enough through the wall to reach the main.

Perhaps the most amusing, but potentially the most dangerous, of these incidents occurred when one of the engineers at the hotel discovered a "pipe fitter" from the utility attempting to disconnect a reducing valve pilot valve from a line carrying 140 psi steam pressure inside the hotel. The engineer inquired whether the "mechanic" had first shut off the line leading to the valve. The man said he had not, and showed some astonishment. He then explained that he was not a pipe fitter, being instead a clerk in the office of the utility.

THOMAS TRAIL

BEAUTY VS. AGE

"You are old, Father William," the young man said,
"And your wool is decidedly gray,
"You're well over fifty-eight, should superannuate,
"Quit gracefully, call it a day!
"It's a sin and shame but it's done just the same,
"Executives sure must be dumb!
"They sit on their hunkers while we fill the bunkers
"And make the machinery hum."

"I can't understand it," the young man said,
"How he runs the equipment and boilers,
"While we educated and much underrated
"Are kept on as juniors and oilers."
(Willie Jones has been here for his thirtieth year,
He knows every bolt on the place,
His ear catches quick every whistle and click,
You can read it right there in his face.)

So after vast powwows and trips to the bowwows
Sir William was granted his pension,
Retiring regretfully, leaving most fretfully,
And things were just lovely, past mention.
For nearly a week there was hardly a squeak,
Then a turbine just grunted and quit,
The feed pumps refused, and injectors were used,
With performance records shot to bits.

A combustion control without any soul
Went on strike with annoying persistence,
We called up the vendors and shippers and senders
Managers, clerks and assistants.
Another machine that hadn't been seen
Developed it's own lot of troubles,
Then off went the stokers, they had to use pokers
And handle the carbon with shovels.

They commandeered half of the maintenance staff,
And sifted them round on the scene,
Got plenty of movement but not much improvement
On engine or pump or machine.
Those ebullient boys who had made all the noise
When the outfit was ticking along,
Kept dignified silence, no help from their science,
"It's only the System that's wrong!"

Many telegrams sped out to hovel and shed,
To resorts where his nibship might be,
But 'twas all in a haze for seventeen days
While locating the old refugee. . .
So Willie's pink ticket hangs there by the wicket,
The commotion subsided completely,
It's somewhat amazing and quite beyond phrasing,
How everything functions so sweetly!

A. E. RICHARDS
Sunnybrook Hospital, Toronto, Ont.

CORRECTION:—BASIC POWER PLANT FIGURING—5

IN THE example under Steam Flash Explanation and Practical Example, June issue, page 69, the original water temperature should have been given as 406.11 F instead of 306.11 F.

Basic Power Plant FIGURING

A Review for Old-Timers — A Must for Young-Timers

By WILLIAM H. ENGELMAN

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What Happens to Steam When it Passes through a Reducing Valve

WHEN STEAM passes through a reducing valve from a higher to a lower pressure, no external work has been done in overcoming the resistance or in reducing the pressure. This reduction in pressure takes place in a very short interval of time; steam at a velocity of 6,000 fpm or 100 fps requires approximately 0.01 sec to pass through the valve. This means that practically no heat loss, either by radiation or otherwise, was possible and can therefore be neglected. Hence, the enthalpy (total heat) in Btu per pound of steam after passing through the reducing valve will be the same as that of the initial steam before it entered the valve.

DRY SATURATED STEAM at high pressure produces superheated steam at the lower pressure and SUPERHEATED STEAM produces more superheat at the lower pressure side of the pressure-reducing valve. The change in enthalpy takes place in the liquid, h_f and in the evaporation h_{fg}. The remaining heat creates superheated steam on the low pressure side. This can best be seen by illustration of A - A' and B - B'.

The weight of dry saturated or superheated steam that will pass through a pressure-reducing valve in a definite time depends upon the pressure on the two sides of the valve, usually termed the high and low pressures, but also known as up-stream and down-stream pressures, respectively. The steam flow through a reducing valve is similar to the flow through an orifice or nozzle, and becomes a maximum when the low pressure is in a certain ratio to the high pressure. This is known as the critical pressure and the following values, accurate enough for all practical purposes, have been experimentally determined:

For dry-saturated steam; the low pressure is 0.58 of high pressure.
Slightly superheated steam; the low pressure is 0.57 of high pressure.
Moderately superheated steam, the

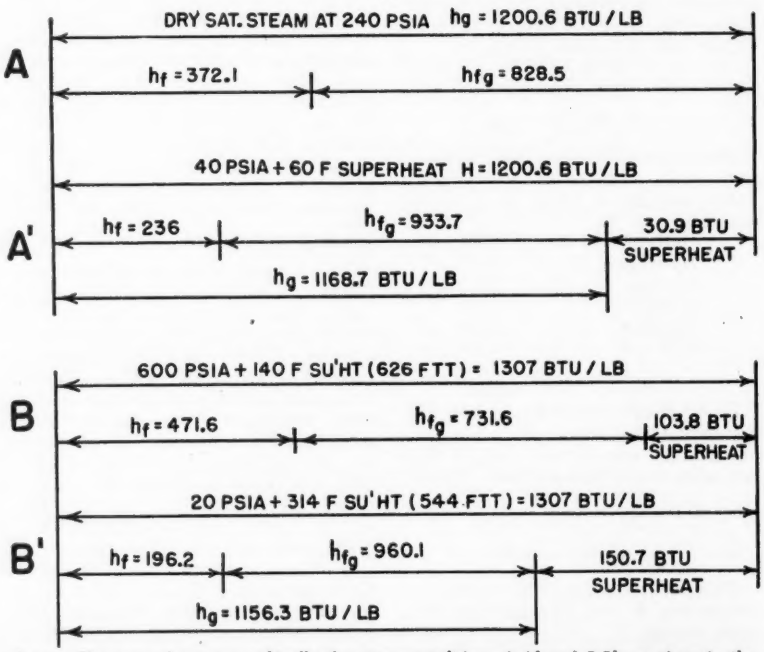

DRY SAT. STEAM AT 240 PSIA hg = 1200.6 BTU / LB
A
hf = 372.1
hfg = 828.5
40 PSIA + 60 F SUPERHEAT H = 1200.6 BTU / LB
A'
hf = 236
hfg = 933.7
30.9 BTU
SUPERHEAT
hg = 1168.7 BTU / LB
600 PSIA + 140 F SU'HT (626 FTT) = 1307 BTU / LB
B
hf = 471.6
hfg = 731.6
103.8 BTU
SUPERHEAT
20 PSIA + 314 F SU'HT (544 FTT) = 1307 BTU / LB
B'
hf = 196.2
hfg = 960.1
150.7 BTU
SUPERHEAT
hg = 1156.3 BTU / LB

Fig. 1. Diagrams showing graphically the steam conditions A-A' and B-B', as given in the table, for steam pressure reduced by passing through reducing valve. Note: The change in specific volume, or cubic feet per pound, is not shown here. That is found from the steam tables

A MOLLIER CHART OF THE PROPERTIES OF STEAM

Modified and Greatly Reduced from KEENAN'S STEAM TABLES and Mollier DIAGRAM Published by the A. S. M. E. in 1930. Reproduced by Permission of the Publishers.

Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.	Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.	Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.
0.0697	32.0	55	297.1	800	518.2
0.2	53.1	60	292.7	850	525.2
0.4	72.9	70	302.9	900	532.0
0.6	85.2	80	312.0	950	538.4
0.8	94.4	90	320.3	1000	544.6
1.0	101.8	100	327.8	1100	556.3
2	126.1	110	334.8	1200	567.1
3	141.6	120	341.3	1300	577.3
4	153.0	130	347.3	1400	587.0
5	162.3	140	353.0	1500	596.1
6	170.1	150	358.4	1600	604.7
7	176.9	160	363.6	1700	613.0
8	182.9	180	373.1	1800	620.9
9	188.3	200	381.8	1900	628.4
10	193.2	220	389.9	2000	635.6
12	202.0	240	397.4	2100	642.6
14	209.6	260	404.4	2200	649.2
16	216.3	280	411.1	2300	655.7
18	222.4	300	417.3	2400	661.9
20	228.0	350	431.7	2500	668.0
22	233.1	400	444.6	2600	673.8
24	237.8	450	456.3	2700	679.5
26	242.3	500	467.0	2800	684.9
28	246.4	550	476.9	2900	690.2
30	250.3	600	486.2	3000	695.2
35	259.3	650	494.9	3100	700.2
40	267.2	700	502.9	3200	704.9
45	274.5	750	510.8	3226	706.1
50	281.0	...	....	....	....

low pressure is 0.56 of high pressure.

Highly superheated steam; the low pressure is 0.55 of high pressure.

For compressed air; the low pressure is 0.53 of high pressure.

That is: The maximum flow has been reached for dry-saturated steam at 100 lb initial pressure when the low pressure is 58 lb.

Manufacturers of pressure-reducing valves furnish reliable data with each valve; their catalogs give excellent descriptions and valuable data on discharge capacities of various sizes of valves throughout the pressure range. They should be consulted first under any circumstances.

Editor's Note:—Nothing is said here about the change in the specific volume of the steam (cubic feet per pound) on passing through the reducing valve. The low-pressure piping and steam consuming equipment are designed to handle the steam at the lower or downstream pressure, and the temperature and the volume of the steam corresponding to the downstream pressure are taken into account in doing this, as will be shown in later articles

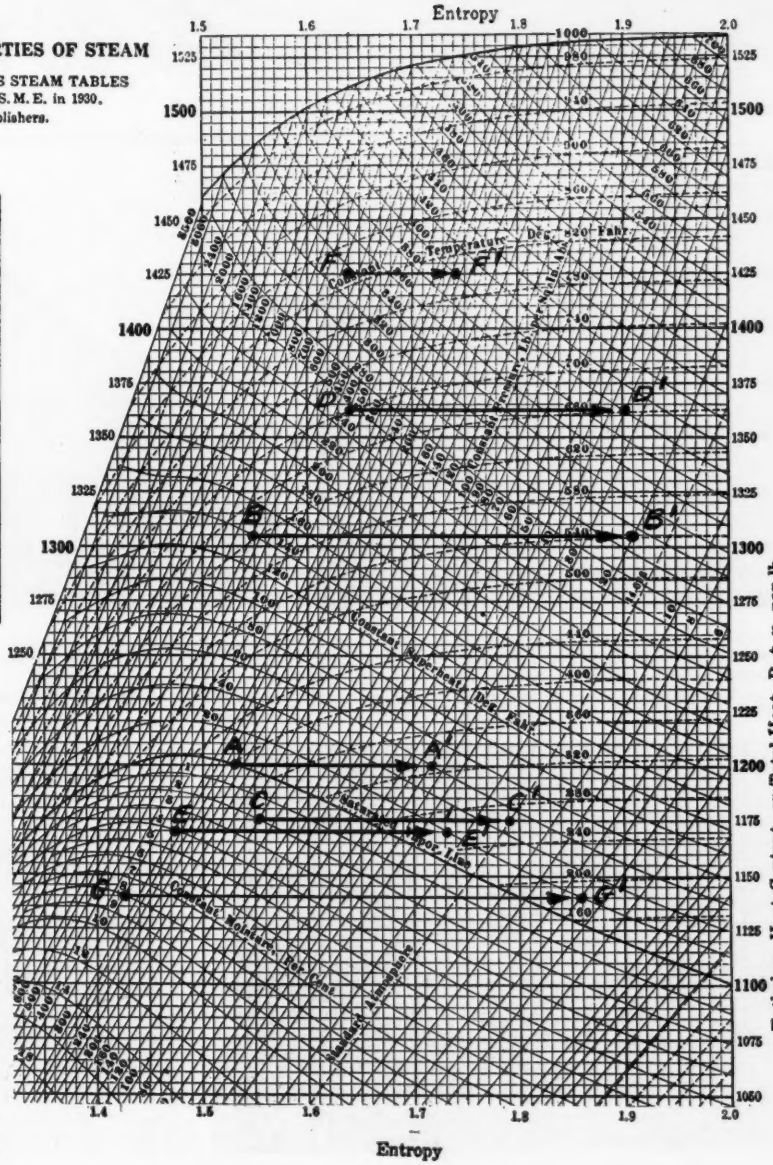


Fig. 2. Portion of Mollier Chart on which are plotted the pressure reductions given in the table

IMPORTANT NOTE: For complete Mollier Chart, see POWER GENERATION, May 1949, page 79. If you want more copies of the complete chart in the reduced 7 by 10 size, the Editors will tell you how to get them.

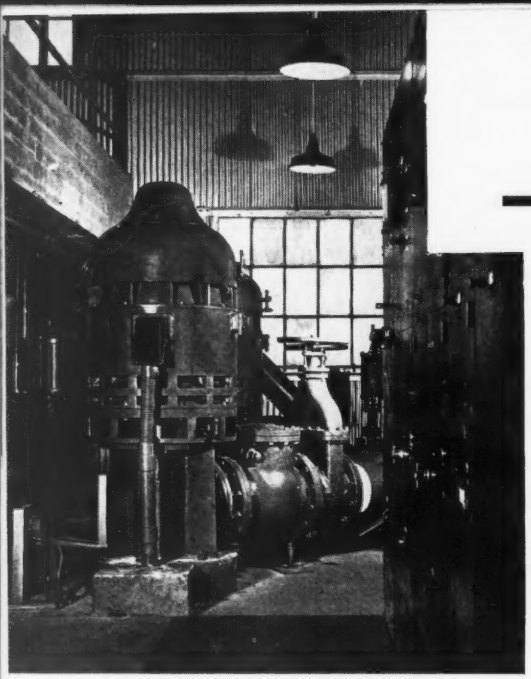
However, for practical problem solving, you should use the 30-by-40-in Mollier Chart supplied in a pocket on the inside back cover of Keenan and Keyes steam tables. Additional copies of this large chart may be obtained from the publishers, John Wiley & Sons, Inc., for a nominal charge.

STEAM AT VARIOUS CONDITIONS REDUCED TO A LOWER PRESSURE BY PASSAGE THROUGH REDUCING VALVE

	INITIAL PRESSURE & TEMPERATURE						FINAL PRESSURE & TEMPERATURE			
Item No.	Pressure Psia	Moisture 0/0	Deg. F Superheat	Total Temp. (T.T.) Deg. F	B.T.U. Per Lb.	Entropy	Pressure Psia.	Total Temp. (T.T.) Deg. F	Superheat Deg. F	Entropy
A-A'	√ 240	√ None	√ None	397.4	1200.6	1.530	√ 40.0	327	60	1.718
B-B'	√ 600	None	√ 140	626	1307	1.548	√ 20.0	544	314	1.912
C-C'	√ 140	√ 2.0	None	353	1176	1.554	√ 14.7	263	53	1.793
D-D'	√ 400	None	255	√ 700	1363	1.640	√ 35.0	660	400	1.904
E-E'	√ 300	4.0	None	417	1170	1.474	√ 24.0	258	20	1.733
F-F'	√ 665	None	338	√ 835	1424	1.637	√ 250.0	803	402	1.742
G-G'	√ 350	8.0	None	432	1140	1.425	√ 5.0	182	20	1.860

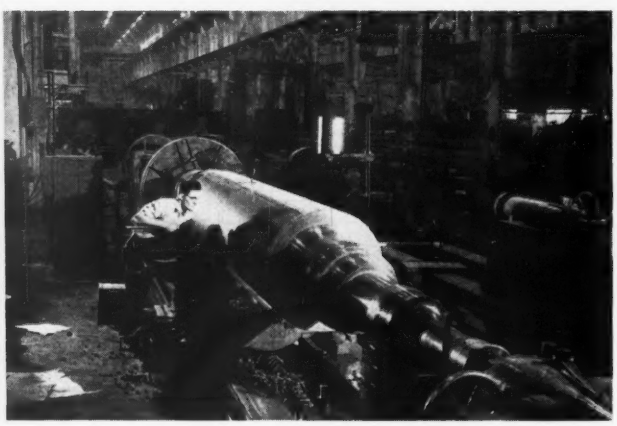
Note: Values marked thus √ are given; other items are to be found. Enthalpy or BTU content is constant for initial and final pressure. Follow horizontal lines on Mollier Chart, as indicated.

Power Generation

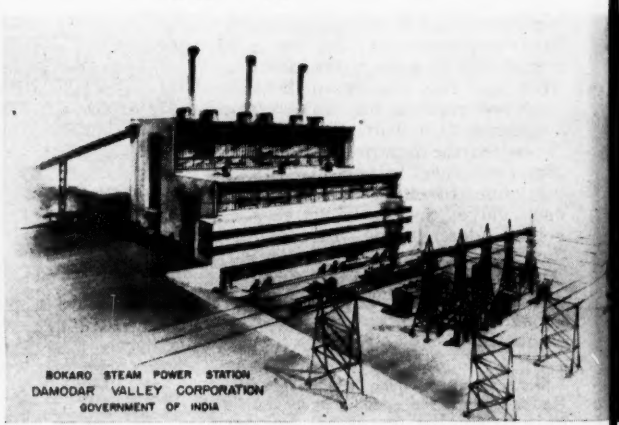


Two vertical centrifugal pumps in water purification plant of Columbia Steel Co's. new sheet and tin mill, Pittsburg, Calif., delivering water to overhead storage tank that supplies processes. All controls for water plant on panel at right

Kreisinger Development Laboratory of Combustion-Engineering-Superheater, Inc. at Chattanooga, Tenn., dedicated April 22, 1949, to memory of Henry Kreisinger, pioneer in research in fuel burning and steam generation, first at Bureau of Mines, 1913-1920, then at Combustion Engineering Co. till his death in 1946

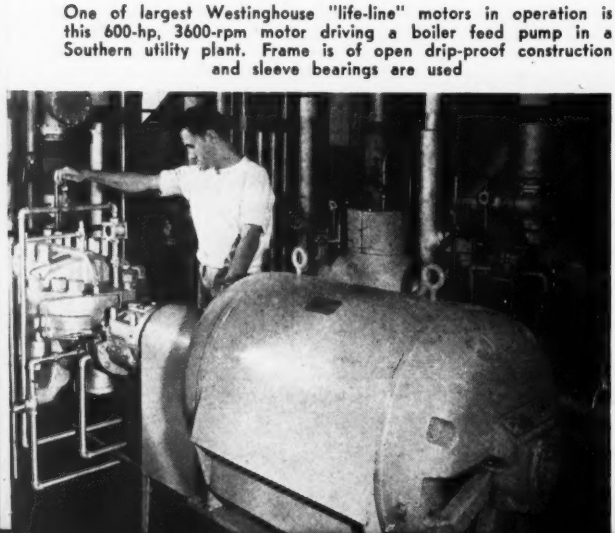


Grooving a 75,000-kw generator field core for air cooling is first lathe operation at GE's new turbine building. Steel forging machined for 8 days by 3 shifts. From here it moves to slotter, where horizontal slots are cut the length of the core

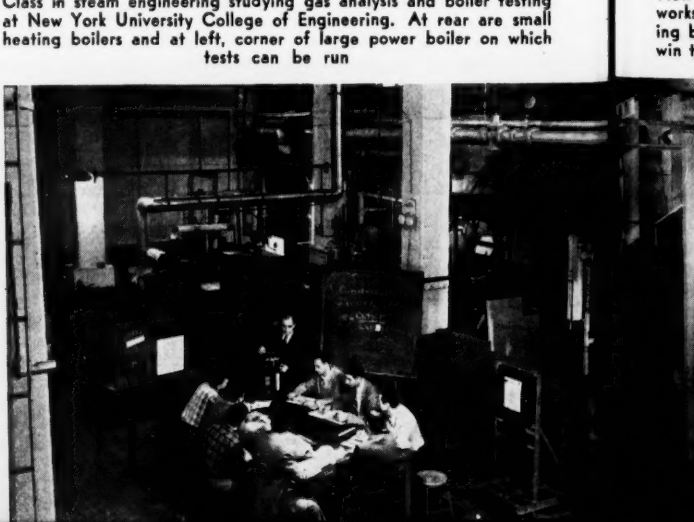


Artist's conception of Bokaro Steam Power Station of Damodar Valley Corp., India, for which equipment is now being ordered from International GE. Order calls for three 50,000-kw steam turbine generators, three power transformers, switchgear, motors

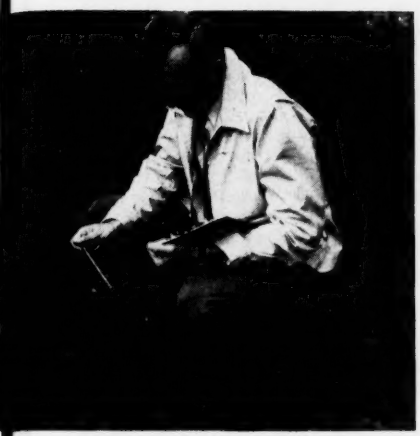
One of largest Westinghouse "life-line" motors in operation is this 600-hp, 3600-rpm motor driving a boiler feed pump in a Southern utility plant. Frame is of open drip-proof construction and sleeve bearings are used



Class in steam engineering studying gas analysis and boiler testing at New York University College of Engineering. At rear are small heating boilers and at left, corner of large power boiler on which tests can be run

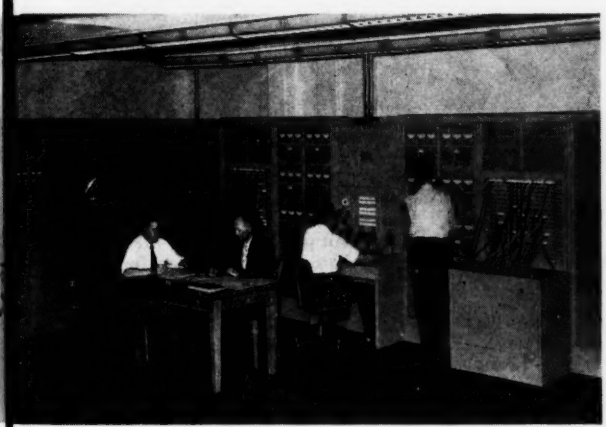


NEWS REEL

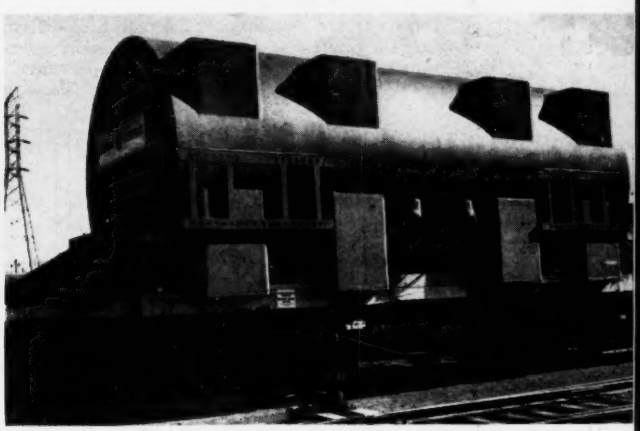


Engineer checking coal pile temperature in coal storage pile maintained for plants of The B. F. Goodrich Co., Akron, Ohio. Thermometers lowered into pipes in pile, temperatures at 9, 6 and 3-ft levels

Turbine erectors install new GE steam turbine generator at Big Sioux Station of Sioux City Gas & Electric Co. The turbine, rated at 10,000 kw, will operate at steam conditions of 325 psi, 700 F and exhaust pressure of 1.5 in. Hg absolute. It will drive a direct connected 6600-v generator at 3600 rpm. Installation of this unit increases capacity of Big Sioux Station from 30,000 kw to 40,000 kw



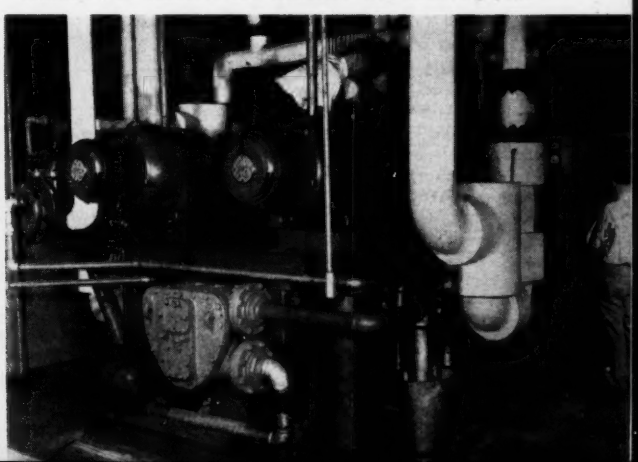
View of new a-c network analyzer at offices of Chief Engineer, Denver Federal Center. Built by GE for the U. S. Bureau of Reclamation, allows study of power systems in Western states. Principal instruments of light-beam type



Stator for 150,000-kw generator en route to Fisk Station of Commonwealth Edison Co. in Chicago. The stator weighs 388,540 lb. was routed over four railroads for clearance, was handled at Chicago on a special 14,100-lb hardwood skid.

New centrifugal pump test floor at Allis-Chalmers' West Allis works. Pumps and motors mounted on hydraulic cylinders and sliding beds for alignment; accurate speed measuring device and Baldwin torque meter for horsepower input; water weighing tanks at left

Educational unit power plant being supplied for study of power generation at University of Nebraska and another at University of Maryland. Two 20-kw turbine generator sets, one 2-pass surface condenser, all auxiliaries and associated load absorbing plant



Starting Up a New Industrial Power Plant With No Outside Power

TO DESIGN a new industrial power plant for completely self-contained operation, with no connections for outside utility power supply, means initial analysis and planning for the methods by which the plant will be started and put on the line, as well as to the necessity for provision of standby equipment and maintenance of service continuity. Here's how these problems, especially the first one, were handled in building the new power plant to serve the new chemical plant of Diamond Alkali Co. recently put into operation at Houston, Texas.

Basis for Design

The new Diamond chemical plant, Fig. 2, is designed to produce 220 tons of chlorine and 240 tons of caustic soda per day. To do this it requires approximately 400,000 lb of steam an hour, 60,000,000 gal of water per day, and approximately 30,000 kw of electric power. Reliable and continuously available water and power services are cardinal requisites for such a plant.

To provide them it was deemed advisable by the Diamond engineers to operate and maintain its own power-generating facilities, for close integration with process requirements, even though abundant, economical utility power was available.

Study of investment in standby units, of output losses due to maintenance and repair outages and possible diversity of partial unit operation indicated no standby equipment would be necessary.

Accordingly, the power plant, Fig. 1, was designed with no provision for outside tie-in of power.

Fuel supply for the new power plant is natural gas, abundant in the area. Instead of oil-burning equipment for supplementary and standby use, two separate sources of gas supply were set up, thus reducing capital investment and eliminating burning of fuel of different characteristics. However, provision is made in the boiler design for future oil firing if desirable. The two gas fuel systems are under automatic control, one system being base loaded, the other regulated to maintain constant pressure.

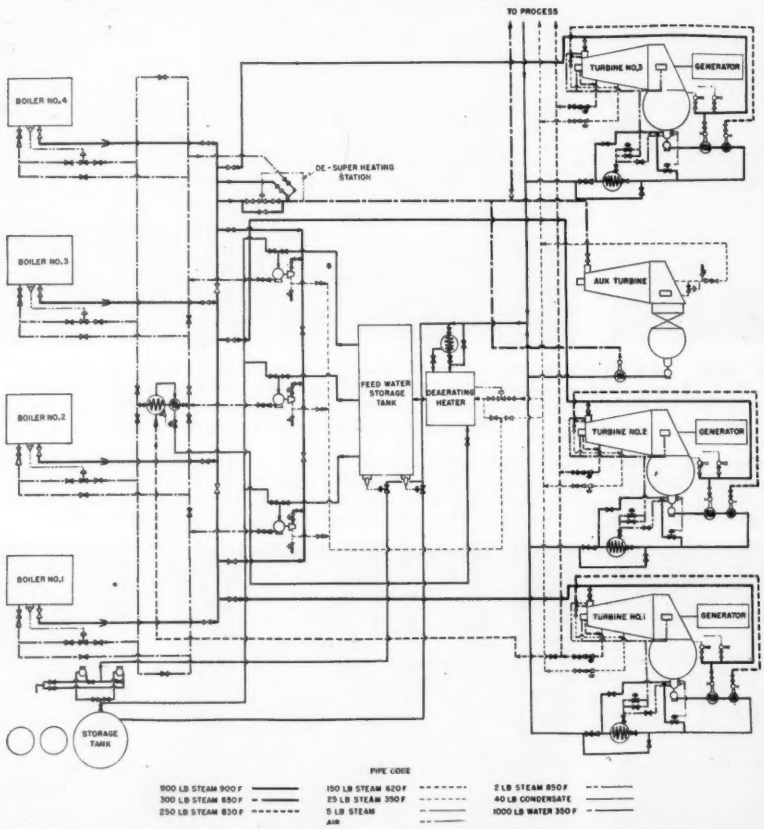


Fig. 1. General flow diagram for steam, condensate and feedwater in 30,000-kw power plant serving Diamond Alkali Co.'s new chemical plant at Houston, Texas

Four outdoor boilers, normal output 100,000 lb per hr each (125,000 lb per hr maximum) of steam at 900 psi, 900 F, with completely water-cooled furnaces and steel casings, are installed. Each boiler is equipped with forced and induced draft fans and a regenerative type air preheater and is under complete automatic combustion control.

Three main turbine-generators are each rated at 10,000 kw 0.8 pf, 3600-rpm, with air-cooled generators. These generate at 13,800 v to meet requirements of a large battery of rectifiers. Each turbine has four bleed points supplying steam at various conditions shown in Fig. 1, and exhausts at 3 in. Hg back pressure to a two-pass, 5500-sq ft divided-water-box condenser bolted to the turbine and spring supported.

Boiler feedwater is normally over 95 per cent condensate, with make-up from the second effect caustic evaporator heaters, neutralized with sulphuric acid and heated in a de-aerating heater of 500,000 lb per hr capacity. From this heater's storage tank, it is drawn by three 500-gpm, 3450-rpm horizontal steam-turbine-driven centrifugal feed pumps, which feed it to the boilers through a single high-pressure, two-pass, U-tube, pressure-sealed-head heater, using steam from 5th turbine stage.

An extensive water system for the entire plant provides water for brine well operation; fresh water for fire protection, drinking and sanitation, water from the Houston Ship Channel for condensing, cooling and other equipment, refrigerated water for product cooling: well water for washing out process piping and equipment, and boiler feedwater. Two fresh water wells provide 1500 gpm in addition, a 300-gpm well pumped by a dual motor and gasoline-engine-driven pump provides a standby source. Well water is chlorinated for potability. The water system includes many pumping units that cannot be detailed here.

Turbine Generator Starting

In designing this plant, due consideration was given to starting it up and an auxiliary steam turbine generator was installed, Fig. 1, for the following reasons.

Before rated steam pressure could be obtained on the boilers, it was necessary to be able to operate the electrically-driven auxiliaries. Also, the turbine condensers had to be provided with cooling water before bringing the generators up to speed. Each cooling water pump was 300 hp. The boiler induced draft fan was 200 hp, and the forced draft fan 100

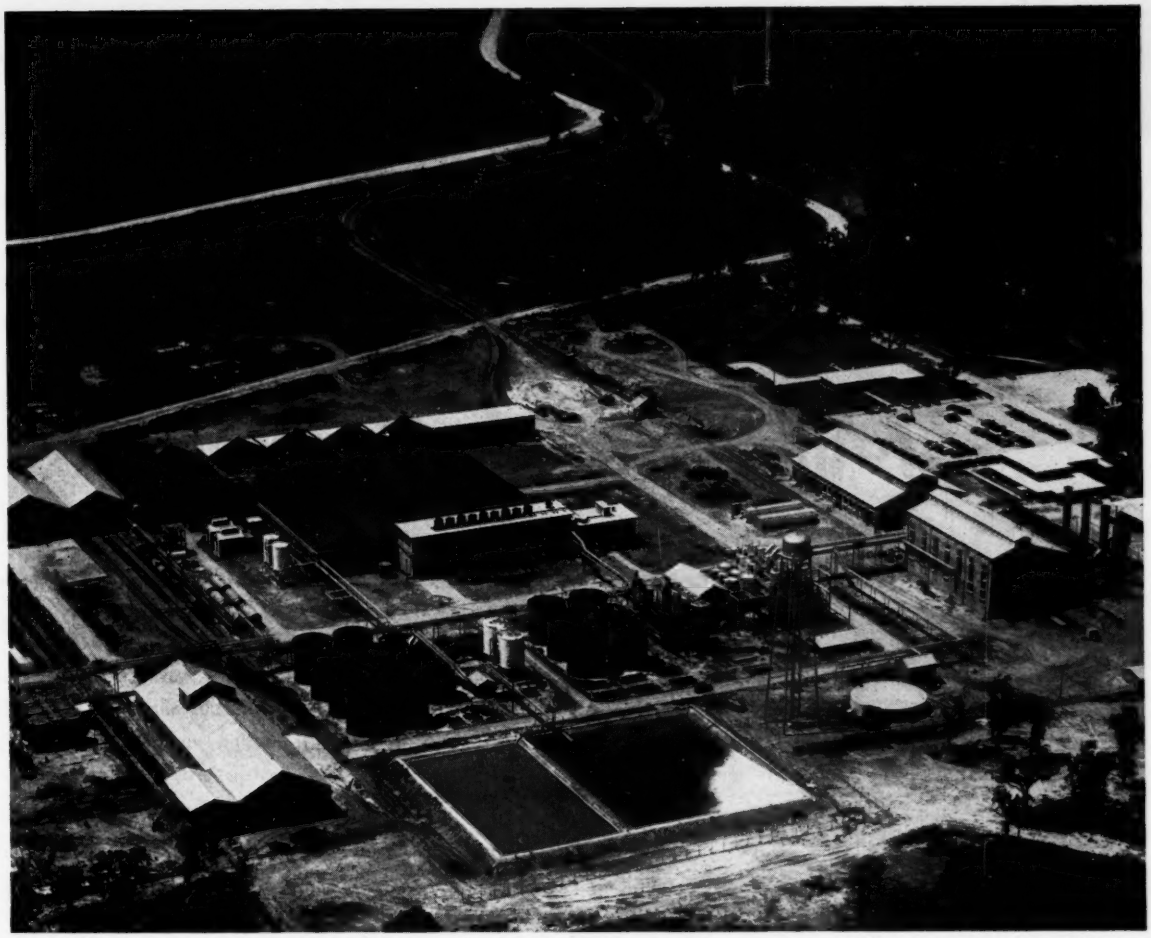


Fig. 2. General view of Diamond Alkali Co.'s new chemical plant at Houston, Texas. At extreme right is power plant from which four semi-outdoor gas-fired boilers and three 10,000-kw turbine generators supply steam and power for production of 220 tons of chlorine and 240 tons of caustic soda per day

hp. Load requirements of various other auxiliaries totaled about 50 hp. Fan motors operated on 440 v, the cooling pumps on 2300 v.

Of course, since no electrical energy was available from the main generators, some means of energizing these auxiliary motors had to be provided until the main generators could be brought up to speed and put on the line. With no outside tie-in planned, the installation of a smaller, auxiliary generator supplied the answer.

Important considerations in the selection of this unit were: delivery time, investment, space, capacity, type of prime mover, and output voltage. A suitable used 1000-kw, 250-psi, 650-F, 3600-rpm turbine generator was obtained designed to operate either condensing or non-condensing and with its generator wound for 440 v.

The unit also incorporated automatically controlled extraction. Put into operation two months before completion of the large turbines, it provided power for construction, permitting trial operation of all electrical equipment in the plant and its extraction steam supplied certain processes for trial operation and furnished steam during low loads on main generators. Using this auxiliary unit and the small gasoline-engine-driven well pump referred to above, it was possible to get the large units on the line in the following manner:

Steps in Starting the Plant

1. Boilers were filled with water using the engine-driven well pump.
2. A gas burner was lighted and the boiler operated on natural draft.
3. When steam pressure rose beyond the feed pressure of the well pump, a turbine-driven boiler feed pump was started.
4. When the pressure reached about 250 psi, the 1000 kw unit was started, exhaust steam being vented to the atmosphere.
5. Voltage was built up on the 1000 kw unit and the switch closed to the 440-volt station bus.
6. The induced draft fan and other necessary auxiliaries were then started.
7. Additional burners were lit and the boiler prepared for greater load.
8. Switch to the powerhouse substation was closed and the power back-fed to the 13,800-volt distribution system, making it possible to transmit power to the intake transformers and to energize one of the 300 hp cooling water pumps.
9. With cooling water now available, the 1000 kw unit was placed in condensing operation.
10. A pressure of 250 psi was maintained on the 1000 kw unit through a reducing station and the pressure in the boiler was raised to a point where a main generator could be started and synchronized into the system.
11. The 1000 kw turbine generator was then shut down to serve either as an emergency unit or to assist subsequently in maintaining a favorable steam balance.

Above data are from unpublished papers by J. R. Horacek, utilities engineer and J. H. Dunlap, utilities superintendent, of the Houston Works of Diamond Alkali Co. Design of the plant was by the engineering department of the company with Brown & Root, Inc. as associate engineers.

THIS MONTH'S *Power Generation* FEATURE

SEWAREN—
Milepost of Progress

History of the engineering development underlying the design of Sewaren Station . . . Influence of the work at Essex . . . Comparison of Sewaren and the 100,000-kw Essex unit . . . Description of the semi-outdoor boilers . . . Central control . . . High temperature parts . . . Auxiliary power system . . . Details of the electrical system . . . Aluminum bus and inert gas shielded welding . . . Structural features of building: heating, ventilating, lighting, etc.

SEWAREN GENERATING STATION of the Public Service Electric and Gas Co. at Sewaren, N. J. went into operation with the first two 100,000 kw generating units in November 1948.

The opening of this station marks an important point in the history of power development because in its design are embodied nearly all of the new ideas that have been accumulating during and immediately after the war. It is the first station to be designed for operation at a steam temperature of 1050 F.

Actually, the design of Sewaren Station began at the Essex Station, one of the older stations of the Company. The Essex 100,000-kw unit, work on which began in March 1945, was a definite step in the development of many Sewaren principles and innovations; indeed, the two may be considered as progressive steps in the same program.

The Sewaren site, located on an arm of the ocean between Staten Island and the New Jersey coast in Woodbridge township was acquired by the Public Service Electric and Gas Co. in 1928. Various studies and methods for developing this site had been made from time to time over a period of years. The essentials of the present layout were developed in a preliminary way in the latter part of 1944, when consideration was also given the removal of an old 22,500-kw unit of Essex Station, and the substitution of a 100,000-kw, 3600 rpm modern unit in its place.

At the time the work at Essex was authorized in March 1945 the capacity situation was uncertain but the installation of the 100,000-kw unit was justified by the economies to be obtained. These amounted to about 16 per cent of the estimated cost of the installation.

In the design of the Essex installation it was decided to adopt a complete unit system, involving a single boiler and a single turbine with no cross connections with any other unit in the station. A shaft-end generator was provided to carry all essential auxiliaries. Central control was also adopted as far as possible in this installation.

Prior to Essex, the largest 3600 rpm generator in existence was rated at 65,000 kw. The Essex main unit was rated at 95,000 kw, and in addition to being the largest gen-

Fig. 1. General view of the turbine room at Sewaren Station, showing the first two 100,000-kw generating units in operation. Note shaft axuiliary generators and fluorescent lighting on the steel trusses

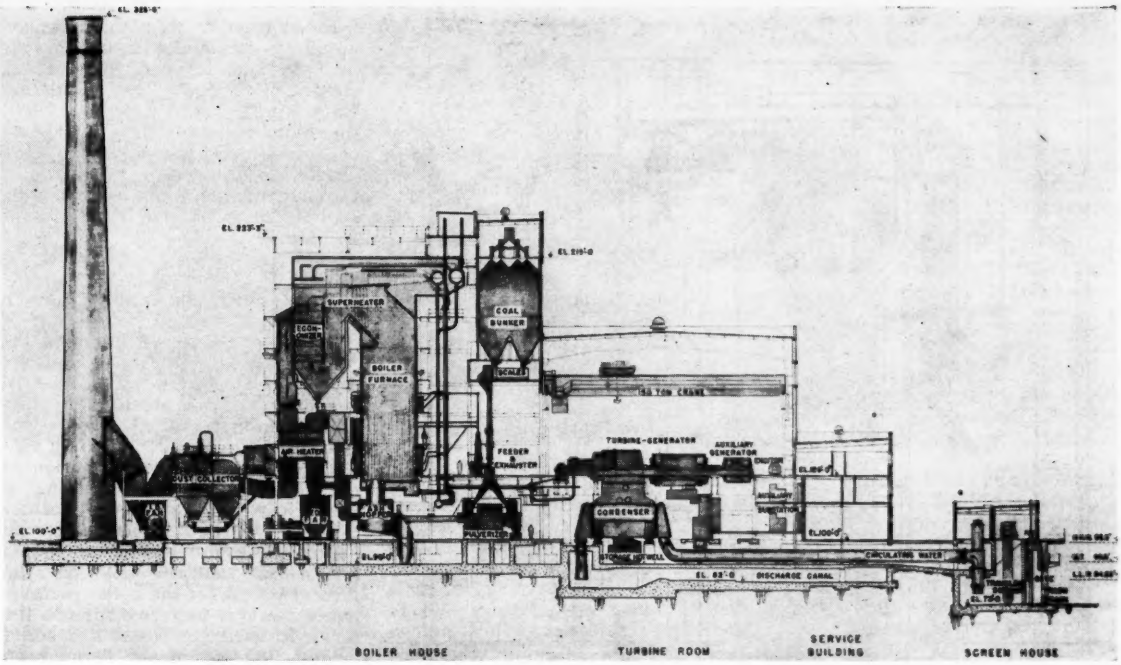


Fig. 2. Elevation of Sewaren Generating Station. Fans, air heaters, dust collectors all outdoors near ground level

erator at that time, it was the first to be designed for a hydrogen pressure of 25 psi. It was also the first 3600 rpm machine to use 23-in. buckets. These buckets were put through very thorough tests in a special test wheel before installation in the turbine.

Forced-and induced-draft fans, air preheaters, and flue gas dust collectors were placed above the boiler, out-of-doors. For this outdoor service the manufacturers, in co-operation with Public Service engineers, developed fans with air cooled bearings, large motors of the totally-enclosed fan-cooled type, and air-to-oil coolers for hydraulic couplings to eliminate water-cooling connections of any kind.

In the interest of simplicity and the reduction of make-up it was decided to omit the usual auxiliary steam header, a departure involving the development of a motor-driven condenser air removal pump, a satisfactory substitute for the usual steam-driven auxiliary oil pump of the turbine, the use of air soot blowing, and the elimination of the reserve steam-driven boiler feed pump. Commercial operation of the Essex unit started in December 1947.

Sewaren Generating Station

On January 21, 1946, authorization was given for the construction of a generating station at Sewaren consisting of two 100,000-kw units to operate at 1500 psi, 1050 F. These two machines started commercial operation at the end of November 1948.

A third Sewaren unit was authorized January 9, 1947. This unit is scheduled to operate in the fall of this year (1949). It is a twin of the second unit.

On December 11, 1947, funds were appropriated for the purchase of a fourth turbine-generator in order to obtain shipment early in 1951. This fourth unit is similar to the first three machines except that it will be rated at 125,000 kw, and will operate with reheat to 1000 F. This is the first time a 3600 rpm turbine-generator larger than 100,000 kw has become available. Studies indicated that the larger machine can be installed in the space provided for the fourth unit without crowding, and that a substantial fuel savings will result from the improved efficiency of the reheat cycle.

The present estimated cost of the four unit station is $132 per kilowatt for nameplate conditions. This includes all electrical equipment to the high voltage side of the transformers.

We are privileged, this month, to present this account of one of the world's most modern and highly developed steam-electric power stations. Sewaren Generating Station of the Public Service Electric and Gas Co. of New Jersey is not only the first station to be designed for an operating steam temperature of 1050 F, but it is also the first station to use turbine generators of 100,000 kw capacity and over, operating at 3600 rpm. Numerous other innovations characterize this station—the complete absence of an auxiliary steam system, for example; the use of semi-outdoor boilers in latitude 41; the complete two-unit system of central control. This article tells something of the history of the thinking and development which led to the design and construction of Sewaren—how the preliminary work was done at the Essex station of the company—how outdoor type of equipment was developed for the Essex unit and how the structural limitations which restricted the design at Essex were overcome at Sewaren. With two 100,000 kw generating units in operation, a third to go into operation in the fall and a fourth 125,000 kw unit scheduled to go into operation early in 1951, the station will have a capacity of 425,000 kw. At a present estimated cost of $132 per kilowatt the total cost of Sewaren Station will be 55 million dollars. The objectives which the designers of Sewaren had was to attain a straightforward, simple arrangement, which with central control would simplify operation and make for minimum manpower per kilowatt; a reasonably efficient cycle that would not be obsolescent at too early a date; and a simple building arrangement involving a minimum of maintenance throughout its life. Whatever future power development may bring, Sewaren will stand for a long time as an important milepost along the complex road of power station development

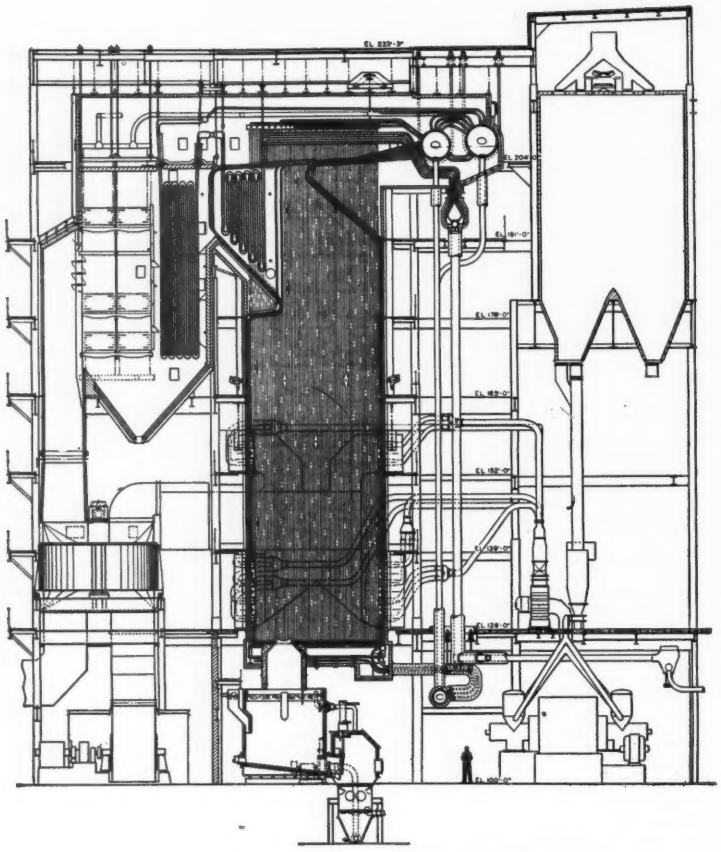
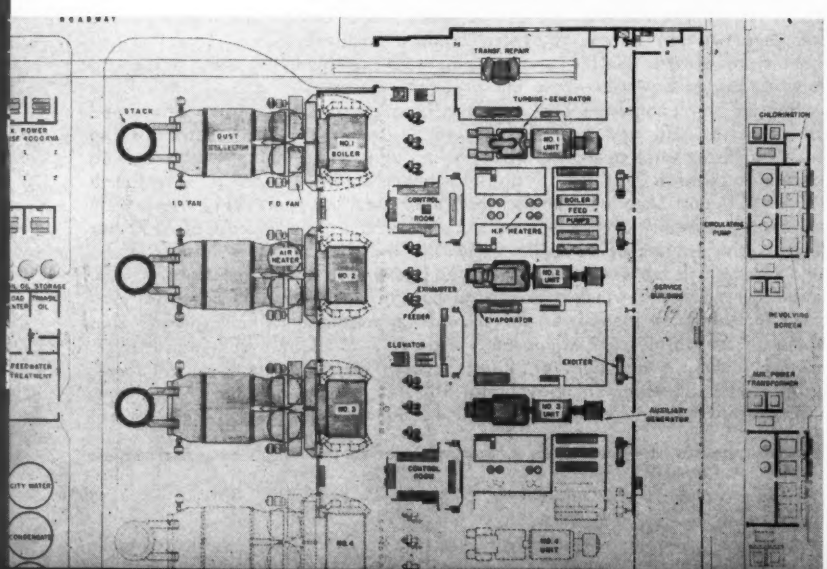


Fig. 3. Cross section through one of the Sewaren boiler units

Sewaren Compared to Essex

The approach to the basic design of Sewaren was the same as that of the new unit at Essex, namely, to develop the unit system to the greatest extent practical. At Sewaren, however, as architectural and structural limitations did not exist, it was possible to accomplish much more in this direction. The Sewaren design makes use of all the features developed at Essex plus two-level operation, semi-outdoor boilers and central control of the units in pairs.

At Essex the new unit was installed in the area for 32 yr occupied by a 22,500-kw turbine-generator and four boilers. The new equipment was arranged to suit the building, whereas at Sewaren, the building was designed to accommodate the equipment. At Essex, on account of limited floor space, the fans, air preheaters, flue dust collector and stack are above the boiler.



In contrast to this, the Sewaren auxiliary equipment is laid out as near ground level as possible as shown by Fig. 2. The circulating water pumps are at the screen well; the fans, air preheaters, and dust collectors are out-of-doors; the stacks are on separate foundations; the pulverizers are placed under the coal bunker. The plant is spread out horizontally.

Semi-Outdoor Boilers

As shown by the exterior view in Fig. 5, the Sewaren boilers are of the semi-outdoor type in which the building encloses the front and one side of each boiler. This type of construction saved about one million dollars in first cost of three units. Because of the smaller building volume and reduced heat radiation in the boiler house the building is easier to ventilate and keep clean.

Boiler overhauls will be on an annual basis and will be scheduled for warm weather. By far the greater portion of the boiler maintenance work is performed inside the boiler furnace, gas passes and boiler drums. Arrangements have been made to keep the inside of the furnaces and gas passages warm during winter shutdowns, not only for maintenance work but also to prevent freezing of the superheaters.

At Essex, where limitations in floor area prevail, the steam generator and its auxiliaries occupy an area of about 60 by 70 ft. At Sewaren, however, where the design objectives included the semi-outdoor feature, two-level operation, and the utmost simplicity, the area occupied by the steam generator and auxiliaries is roughly 160 ft by 50 ft, about twice the area used at Essex. The drums and superheater outlet header are offset from the furnace so that they are housed in the building. This facilitated the semi-outdoor design of the boiler house.

Each of the first three Sewaren boilers is of the three-drum, radiant type, having a continuous rating of 850,000 lb per hr and a maximum of 950,000 lb per hr for four hours with throttle conditions of 1500 psi and 1050 F. The slag-tap furnace, which has a volume of 52,450 cu ft, is arranged for tangential corner firing at two levels with combination pulverized coal and oil burners, vertically adjustable to permit positioning of the turbulent burning zone in order to obtain optimum slagging conditions on the walls and floor of the furnace to effect a certain amount of superheat control. Final steam temperature is controlled by a damper which by-passes part of the furnace gases from the primary superheater to the economizer. A temperature controller automatically regulates the superheated steam temperature by positioning the electrically oper-

Fig. 4. Plan at the operating floor level

Fig. 5. Exterior view of the boiler end of Sewaren Generating Station

ated superheater by-pass damper. Tilting of the top sets of four burners is accomplished electrically by remote manual control from the control room. The lower sets are adjusted manually. As at Essex, there are three pulverizers, two Ljungstrom air heaters, an economizer and two forced- and two induced-draft fans. The dust collector is a combination mechanical-electrostatic unit, with the mechanical section ahead of the electrostatic.

Soot Blowing

High pressure air soot blowing is used to clean the boiler, furnace, superheater, economizer and air heater. Automatic sequential operation of the blowers is controlled and indicated in the control room. Compressed air is stored in outdoor receivers at 500 psi and reduced to 250 and 350 psi for soot blowing. Retractable units operating at 250 psi clean furnace walls, the second stage of the superheater, and the air heater. Puff type revolving blowers clean the first stage of the superheater and the economizer with 320 psi air.

Since many of the soot blower heads are located out of doors, the power air for controlling and moving the blowers is dried by silica gel before it enters the system.

Turbine Design and Heat Rates

At its best point, the Essex unit has a calculated plant heat rate (based on turbine guarantees) of 10,400 Btu per net kwh. Steam conditions are 1250 psi, 1000 F and the turbine has a double-flow low-pressure cylinder. This unit operated 8149 hours of the 8784 hours in 1948 at an average turbine load of about 97,800 kw. The capacity factor was 90.7 per cent. The average heat rate for the year was 10,500 Btu per kwh, which is approximately the calculated rate for that load. The average circulating water temperature was 60.6 F; average back-pressure was 1.36 in. Hg. The unit operates regularly at a rating of 110,000 kw.

No. 1 Unit at Sewaren is essentially similar to Essex No. 1 except that the steam conditions are increased to 1500 psi and 1050 F. The improvement in heat rate is 4.6 per cent at best point. This increment includes a one-point improvement in boiler efficiency.

Nos. 2 and 3 Units at Sewaren are similar to No. 1 Unit except that they have triple-flow low-pressure cylinders. The improvement over No. 1 Unit (Sewaren) is 1.4 per cent at the best point.

No. 4 Unit is similar to Nos. 2 and 3 at Sewaren except that it is a larger machine and the steam is reheated to 1000 F. The improvement over Nos. 2 and 3 Units is 4.0 per cent at best point.

The calculated plant heat rates for the units are shown in Fig. 7. The heat balance diagram for Nos. 2 and 3 Units at Sewaren (Fig. 6) is typical. The system operates without a heater drain pump. Although the diagram does not show it, the hotwell pump is of the re-entry type. The condensate re-entry is made after passing through the con-

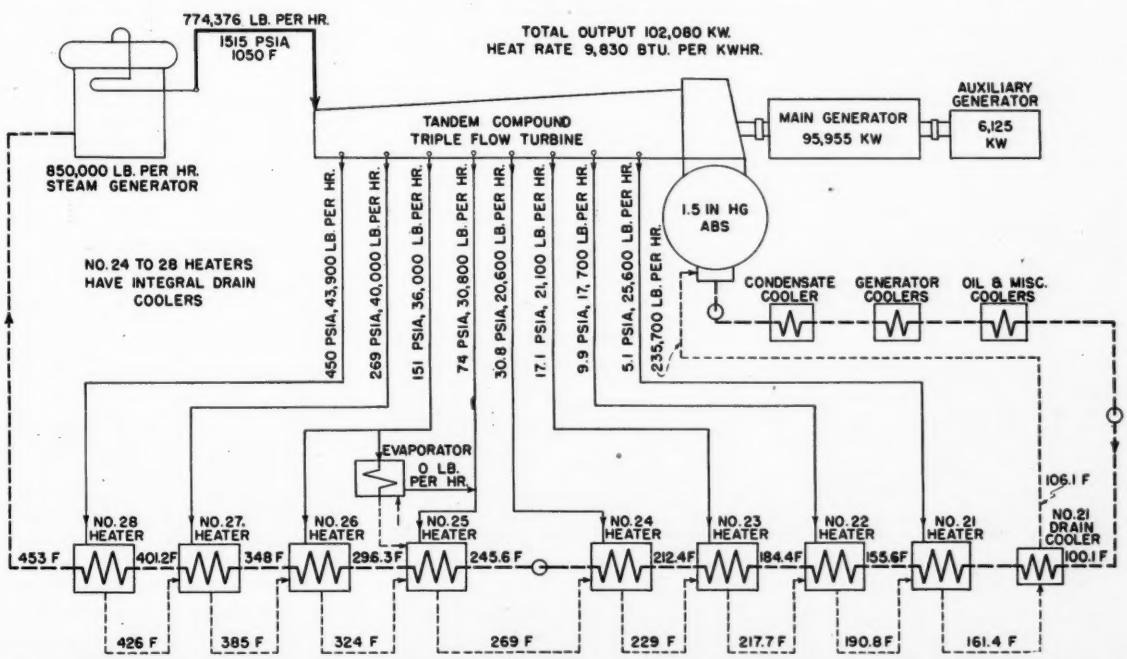


Fig. 6. The heat balance diagram for units No. 2 and 3. Although not shown on this diagram, the hotwell pump is of the re-entry type. The condensate re-entry is made after passing through the condensate cooler, generator hydrogen and air coolers and oil and miscellaneous coolers

Principal Equipment For Nos. 1, 2 and 3 Units At Sewaren

Designers ..... **Electric Engineering Department, Public Service Electric and Gas Co.**
Builders ..... **United Engineers & Constructors, Inc.**
Architectural Consultants ..... **Walker & Poor**

TURBINE-GENERATORS AND AUXILIARIES

1 Turbine-generator having nameplate data as follows: Steam turbine, rated kw 100,000, maximum kw 109,500, initial pressure 1500 psi, initial temperature 1050 F, exhaust pressure 1.5 in. Hg, rpm 3600, 32 stages. A-C generator, rated 121,176 kva, power factor 0.85 hydrogen pressure 30 psi, frequency 60 cycles, phases 3, voltage 13,100 to 14,500, star connected, speed 3600 rpm. Auxiliary A-C generator, rated 9375 kva, power factor 0.80, air cooled, speed 3600 rpm—Westinghouse Electric Corp.

2 Turbine-generators, each having nameplate data as follows: Steam turbine, rated 100,000 kw, 23 stages, speed 3600 rpm, maximum capacity 108,500 kw, steam pressure 1500 psig, temperature 1050 F, exhaust pressure 1.5 in. Hg abs.

A-C generator, hydrogen cooled, 2 poles, 60 cycles, 3 phase wye conected for 13,800 volts, rating at 15 psig hydrogen pressure 111,765 kva at 0.85 power factor, armature 4670 amp, field 1040 amp, exciter 250 volts. Capacity at 25 psig hydrogen 117,647 kva at 0.85 power factor, armature 4920 amp, field 1070 amp.

Auxiliary A-C generator, rated 9375 kva, power factor 0.80, air cooled, speed 3600 rpm—General Electric Co.

3 Single-pass, divided water box, spring supported, welded steel-shell condensers with storage type deaerating hotwell, one 50,000 and two 60,000 sq ft surface, with ⅞ in. OD, No. 18 B.W.G. aluminum brass and aluminum bronze tubes — Foster Wheeler Corp.

9 Low Pressure, 2-pass, closed feedwater heaters located horizontally in the condenser neck—Westinghouse Electric Corp.

3 Low pressure, 4-pass, closed vertical feedwater heaters and 12 high pressures, 2-pass, closed vertical feedwater heaters—Foster Wheeler Corp.

3 Condensate Coolers, using salt water for cooling—Graham Mfg. Co.

STEAM GENERATING UNITS AND AUXILIARIES

3 Boilers, each rated 850,000 lb/hr continuous, 1500 psi, 1050 F throttle steam conditions, 52,450 cu ft furnace vol., 15,080 sq ft boiler heating surface, vertically adjustable, tangential firing burners, continuous slag tap; 2-stage pendent convection superheaters, 41,800 sq ft heating surface; continuous tube, counter flow, 39,600 sq ft economizer—Combustion Engineering-Superheater, Inc.

6—104,350 sq ft Ljungstrom regenerative air heaters—Air Preheater Corp.

Superheater and economizer refractory walls, sectionally supported—M. W. Detrick Co; George Allen & Son.

3 Ash Hoppers, 3 ash pumps and 1 dewatering bin—Allen-Sherman-Hoff Co.

Ductwork—Connery Construction Co.

Boiler and boiler gas duct insulation—H. W. Porter Co.

Hot air duct insulation—Chas. S. Wood Co.

Air soot blowers, automatic sequential operation—Diamond Power Specialty Corp.

9 Hardinge pulverizers, 19 tons per hr; 9 raw coal feeders; and 9 mill exhausters—Foster Wheeler Corp.

6 Variable-speed forced draft fans, driven through hydraulic—American Blower Corp.

6 Air-cooled radiators for cooling the oil of the forced draft fan hydraulic couplings—Young Radiator Co.

6 Induced draft fans, 2 driven through hydraulic couplings, 4 louvre controlled—American Blower Corp.

2 Fan-cooled radiators for cooling oil in the induced draft fan couplings—General Electric Co.

3 Stacks, double shell, radial brick, 225 ft high, 15 ft diameter at top—M. W. Kellogg Co.

Zeolite water softening system—Worthington Pump & Machinery Corp.

3—30,000 lb per hr evaporators—2 Foster Wheeler Corp; 1 Griscom-Russell Co.

3 Evaporator deaerators — Worthington Pump & Machinery Corp.

COAL HANDLING EQUIPMENT

Unloading tower and barge puller—McKiernan-Terry Corp.

Bradford breaker — Pennsylvania Crusher Co.

Conveyors, traveling tripper and swing boom—Robins Conveyors, Division of Hewitt-Robins, Inc.

Conveyor belts—Thermoid Rubber Co.

Magnetic separator—Ding's Magnetic Separator Co.

Weightometer—Merrick Scale Mfg. Co.

12 Automatic coal scales—Richardson Scale Co.

Raw coal hoppers and stainless steel chutes—Hellman Boiler Works and Allied Steel Products Corp.

Gates in raw coal chutes and at bunker outlets—Stock Engineering Co.

2 Tractors, bulldozers and carryalls—Smith Tractor Co. and Eastcoast Equipment Co.

DUST HANDLING EQUIPMENT

Dust collectors, multiclone-Cottrell—Western Precipitation Corp.

Fuller-Kinyon dust conveying system—Fuller Corp.

Redler conveyors between precipitators and dust pump hopper — Stephens-Adamson Mfg. Co.

Variable Speed Drives—Reeves Pulley Co.

Screw conveyors between economizers and dust pump hoppers—Link Belt Co.

Star Feeder valves, precipitator and economizer hoppers—United Conveyor Corp.

Dust storage silo—Hellman Boiler Works.

PUMPS

6 Vertical, mixed flow, 47,000 gpm, 345 rpm circulating water pumps — Foster Wheeler Corp.

6 Rotating plunger type, single-stage, vacuum pumps, 550 cfm at 1.5 in Hg—Kinney Mfg. Co.

6—2090 gpm at 517 ft head, 884 rpm, vertical, centrifugal 4-stage, re-entry type condensate and booster pumps—Worthington Pump & Machinery Corp.

9 Horizontal, centrifugal 8-stage boiler feed pumps, 1115 gpm at 4680 ft head, 3465 rpm—Worthington Pump & Machinery Corp.

9—2000 hp, 3550 rpm variable-speed hydraulic couplings driving boiler feed pumps—American Blower Corp.

4 Vertical, DeLaval, 2500 gpm at 250 ft head, 1760 rpm salt water service pumps—Turbine Equipment Co.

3—2000 gpm at 25 ft head ash sluice pumps—Worthington Pump & Machinery Corp.

1—1600 gpm centrifugal fire pump—Goulds Pumps, Inc.

1—500 gpm city water booster pump—Goulds Pumps, Inc.

3 Vertical, DeLaval, rotary screw, fuel oil pumps, 140 gpm at 325 psi—Turbine Equipment Co.

2 Pumps for acid cleaning system, 1000 gpm at 70 ft head—Worthington Pump & Machinery Corp.

9 Sump Pumps—Quimby Pump Div., H. K. Porter Co., Inc.

2 Condensate storage tank pumps—Ingersoll-Rand Co.

3 Evaporator feed pumps—Gould Pumps, Inc.

1 High pressure chemical feed pump—Worthington Pump & Machinery Corp.

4 Continuous chemical feed pumps—Milton Roy, Inc.

2 Condensate return pumps—Worthington Pump & Machinery Corp., and Federal Pump Corp.

1 Circulating Pump for oilostatic cable cooling—Sier-Bath Gear & Pumps Co., Inc.

1 Laboratory vacuum pump — Schutte & Koerting Co.

2 Fuel oil reclaiming pumps—Sier-Bath Gear & Pump Co., Inc.

AIR COMPRESSORS

4 Horizontal, single-phase, 150 cfm at 100 psi carbon ring control air compressors—Ingersoll-Rand Co.

1 Horizontal, duplex, 2-stage, 660 cfm at 125 psi station service air compressor—Ingersoll-Rand Co.

2 Rotary, 2-stage, 1035 cfm at 120 psi soot blower air compressors—Fuller Co.

2 Horizontal, single-stage 1000 cfm at 500 psi high pressure soot blower air compressors—Ingersoll-Rand Co.

6 Dual tower silica gel air dryers for control air—Dehydraire Corp.

1—1000 cu ft, 500 psi air receiver—A. O. Smith Corp.

3—60 cu ft, 250-320 psi air receivers—American Locomotive Co.

INSTRUMENTS AND CONTROLS

Three-element control of boiler feed pump speed—Bailey Meter Co.

Automatic combustion control equipment—Hagan Corp.

160-point bearing and superheater tube temperature recorders; and 90-point miscellaneous temperature recorder—Leeds & Northrup Co.

Automatic control of superheater by-pass damper—Leeds & Northrup Co.

Condenser hotwell level control equipment—Hagan Corp.

Automatic fuel oil pressure control—Hagan Corp.

Yarway remote boiler drum level indicators—Yarnall-Waring Co.

Boiler meters—Bailey Meter Co.

Clear and bi-color gage glasses for boiler drums—Diamond Power Specialty Corp.

Miscellaneous gage glasses — Ernst Water Column & Gage Co.

Boiler draft and pressure gages—Republic Flow Meters Co.

Ashcroft Duragages—Hajoca Corp.

Co_2, pH, temperature and conductivity recorders—Leeds & Northrup Co.

Industrial thermometers — Taylor Instrument Co.

PIPING

Main steam and high pressure boiler feed—M. W. Kellogg Co.

Intermediate and low pressure — Midwest Piping and Supply Co.; Cornell & Underhill.

Circulating water 48 in. reinforced concrete—Lock Joint Pipe Co.

Strainers—Andale Co., Leslie Co.

Insulation—Chas. S. Wood & Co.

VALVES

Steel gate and check valves, high pressure—The Lunkenheimer Co.

Steel gate and check valves—Wm. Powell Co.; Walworth Co.

Safety valves — Foster Engineering Co.; Manning, Maxwell & Moore, Inc.

Bleeder check valves—Schutte & Koerting Co.

Boiler blowdown valves — Yarnall-Waring Co.

Regulating valves—Bailey Meter Co., Fisher Governor Co., Swartwout Co., Schutte & Koerting Co.

Pressure relief valves—Manning, Maxwell & Moore Inc., Farris Engineering Co., Foster Engineering Co., Crosby Steam Gage & Valve Co.

Iron Valves—Crane Co., Chapman Valve Mfg. Co., Darling Valve and Mfg. Co., Walworth Co.

Butterfly valves for circulating water—Henry Pratt Co.

ELECTRICAL EQUIPMENT

9 Reactors, single-phase, mid-tap, 5000 amps—General Electric Co.

4 Transformers, 85,000 kva, 13.2-132 kv, forced oil-forced air—Westinghouse Electric Corp.

4 Transformers, 51,000 kva, 13.2-26.4 kv, forced air—General Electric Co.

4 Station power transformers, 4000 kva, 26-4-2.4 kv—Moloney Electric Co.

2 Station power transformers, 1500 kva, 2400-440 v—Allis-Chalmers Mfg. Co.

Lightning arresters, 15 kv—6 General Electric Co.; 3 Westinghouse Electric Corp.

Oil circuit breakers, 15, 34.5 and 132 kv—Westinghouse Electric Corp.

Main generator leads of oilostatic cables—Okonite-Callendar Cable Co., Inc.

Auxiliary generator lead housings—Railway and Industrial Engineering Co.

Disconnecting switches 7.5, 23, 34.5, 132 kv—Railway and Industrial Engineering Co.

Delta Star Electric Co., Pringle Mfg. Co.

228 Transformer cooling fans—Diehl Mfg. Co.

Metal clad switchgear, 2400 and 440 v—Westinghouse Electric Corp.

Load centers, 220 v—Westinghouse Electric Corp.; I-T-E Circuit Breaker Co.

Storage batteries, 125 and 250 v—Electric Storage Battery Co.

Electric motors, 220, 440 and 2400 v, 3 phase, 60 cycles—Westinghouse Electric Corp.,

(Continued on page 128)

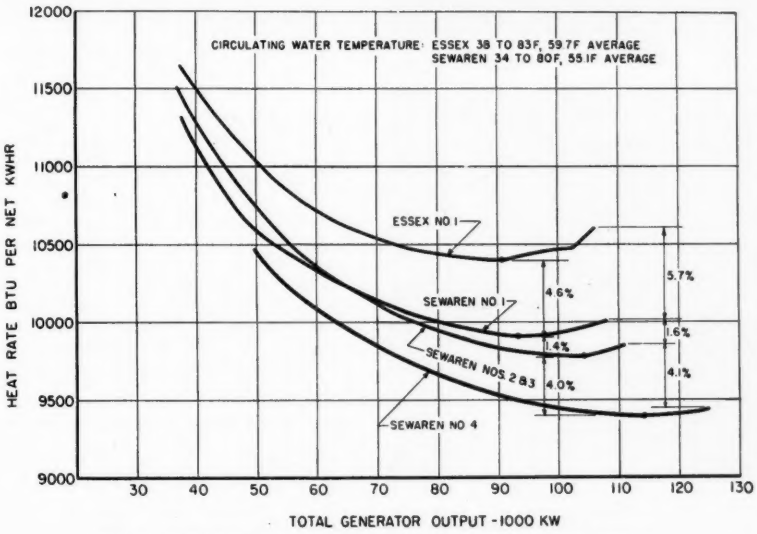


Fig. 7. Calculated heat rates for the four generating units at Sewaren

densate cooler, generator hydrogen and air coolers, and oil and miscellaneous coolers.

The first three extraction heaters are located in the neck of the main turbine condenser, thus shortening the piping to these units.

Central Control

Unit design, with only one boiler per turbine, greatly facilitates central control in a modern electric generating station. For example, the control panel areas of No. 1 Unit at Sewaren compared with the corresponding areas of No. 6 Unit at Burlington, a 125,000-kw cross-compound unit with two cross-connected boilers installed in 1943, show some interesting figures. At Sewaren there are 521 sq ft of panel in one location; at Burlington there are 695 sq ft in five separate locations. This concentration of control results in better coordinated operation and a reduction in operating attendance.

The two Sewaren control rooms (Figs. 4, 8 and 9) are tee shaped, with the electrical bench board (Fig. 9) forming the cross-bar. The operator sees the two turbine-generators through windows just above the bench board. The other sides of the room (Fig. 8) are occupied by the panels controlling the turbines, boilers and their auxiliaries. At the rear, there are two windows looking toward the boilers. There are three operators in the control room. Normally, one operates the electrical bench board of two units, and each of the other two operates the mechanical equipment of one unit. The operators are, however, trained to handle both mechanical and electrical controls, and at present, each one rotates around the three operating jobs in the control room. The control rooms are air conditioned and soundproofed. Special attention was given to the lighting, particularly of the vertical panels, for which totally indirect lighting is provided by means of a cove and arched ceiling design. In the areas between sections of arched ceiling, vinylite eggcrate plastic was used to provide a luminous ceiling, which avoids the contrast between lighted and unlighted areas which a solid ceiling would have given. The final design was the result of studies made of a mock-up erected in the basement of the Public Service Terminal Building in Newark, N. J.

Each control room is situated at the center of the area occupied by the main equipment under its supervision (Fig. 4).

High-Temperature Parts

The steels used in the pressure parts exposed to the highest temperature steam are listed in the accompanying table (page 72).

At Sewaren each unit has two welded joints between the austenitic steel of the stop valves and the ferritic steel of the steam piping. As the stainless steel expands about 50 per cent more than the chrome-moly in the range from 70 to 1050 F, there was some concern about the adequacy of a welded joint between the two metals in heavy wall thickness. With the co-operation of the boiler, turbine and pipe suppliers a cyclic heating test was made on several full size, heavy wall welded pipe joints between austenitic and ferritic steels. This test has been fully described in another paper (1). The Kelcaloy transition piece finally selected is shown in Fig 10. The purpose of this arrangement is that the major portion of the interface between the dissimilar metals is longitudinal to the pipe rather than transverse, and therefore is subject principally to shear stress resulting from internal pressure or bending. If failure occurs at the joint between the two metals it should appear as a lap or lamination rather than a separation straight across the pipe. The transition piece is welded to the stop valves in the shop, leaving a ferritic weld to be made in the field.

The spindles of the stop and control valves of Nos. 2 and 3 turbines at Sewaren are *cooled with steam from the intermediate header* of the superheater. No. 1 turbine valves are not provided with any cooling arrangement.

Auxiliary Power

Shaft-end auxiliary generators are used to provide the essential auxiliaries with a direct source of power free from outside disturbances. Normally each auxiliary generator carries the essential auxiliaries of its own unit. It is rated 7500 kw at 2400 v, 80 per cent power factor, and is separately excited. The 2400 v auxiliary buses of each unit can be fed either from the auxiliary generator or from auxiliary transformers connected to an outside source. The two are never paralleled. Relays are installed to throw over automatically from generator to transformer in case of loss of voltage

Fig. 8. A general view of the No. 1 and 2 control room. This view shows the boiler and turbine control boards with a portion of the electrical control board in the immediate foreground

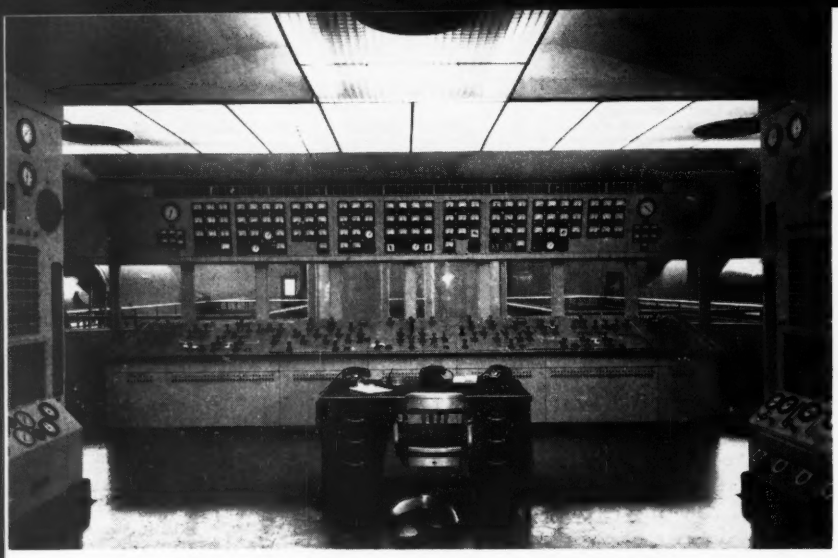


Fig. 9. A view in the No. 1 and 2 control room facing the turbine room. This shows the electrical control equipment. The main generating units can be seen through the windows

on the generator. Manual throw-over in the other direction is provided for transferring auxiliaries from transformer to auxiliary generator when starting up.

Auxiliaries

Steam from the high-pressure boilers is used only to run the main turbines. All auxiliaries are electric motor-driven. At Sewaren, steam for heating fuel oil, mixing chemicals and heating the building is supplied normally from the evaporators. There is a heating boiler for use in the event of a complete station shut-down. Every effort has been made to reduce make-up to the minimum.

With the shaft-end auxiliary generator as the source of auxiliary power, the elimination of steam-driven auxiliaries becomes a relatively easier step in station design. One of the problems in this connection was the substitution of motor-driven, positive displacement, rotary vacuum pumps for the usual steam jet ejectors for the removal of non-condensible gases from the condenser. Before proceeding with this new departure a Kinney pump of this type was tried out on No. 10 Condenser at Marion Generating Station for about 1000 hours. This test revealed that most of the troubles were related to separating the lubricating oil from the water vapor associated with the gases coming from the condenser air coolers. As these difficulties appeared to be surmountable, it was decided to use Kinney pumps at Essex because they offered the following advantages over the steam jet air pumps: (a) sufficient capacity at low vacuum to eliminate the need of starting evactors, (b) adaptability to remote push-button starting and stopping, and (c) more complete removal of corrosive gases such as ammonia and carbon dioxide from the system, as there are no inter- and after-condensers (or, alternatively, no wastage of condensate to get rid of these gases).

It was evident after a few months operation of the Essex pumps that they would do the job and accordingly orders were placed for the Sewaren pumps. Operating experience to date has confirmed the expectation of satisfactory operation.

The traditional steam-driven auxiliary oil pump of the turbine-generator was replaced by a full capacity a-c motor-driven pump backed up by a smaller d-c motor-driven pump operating from the station battery. This latter pump has sufficient capacity to bring the turbine-generator to a stop if both main and auxiliary pumps should fail.

Fuel Handling and Storage

Sewaren is designed for normal operation with water-borne fuel. From a coal unloading tower and breaker house the coal is sent either to the bunker or to a Swing Boom Tower for storage by tractor and carryall. Both the dock and the unloading tower are designed so that in the future the unloading tower could be mounted on wheels and moved along the dock. Coal arriving by rail or reclaimed from yard storage is dropped into track hoppers feeding a conveyor to the Breaker House. A 125,000-barrel fuel oil tank is located north of the main building.

Principal Electrical Features—Sewaren

The ultimate connections of the four Sewaren generators to the system are shown in Fig. 11. Each generator feeds into the mid-point of a reactor which takes the outgoing current into two channels. All switching is done between the generator and transformer at 13 kv, except for one 132-kv oil circuit breaker which ties together two lines, closing a transmission loop when the station is shut down. The 26-kv circuits feed the area immediately adjacent to Sewaren while the 132-kv lines connect to the transmission system for utilization in more remote areas.

The 13-kv generator leads extend about 500 ft to the transformer yard in 8-in. oilostatic pipes in tunnels on foundation slabs carrying station power and control cables in one case, and transformer track supports in another case.

Placing the oilostatic cables in

Steels Used in Pressure Parts Exposed to Highest Temperature Steam

	ESSEX	SEWAREN	
	No. 1	No. 1	Nos. 2 and 3
Steam Temperature	1000 F	1050 F	1050 F
Superheater Tubes	9% Chromium 1.3% Molybdenum	19% Chromium 11% Nickel Titanium stabilized	19% Chromium 11% Nickel Titanium stabilized
Steam Piping	2¼% Chromium 1% Molybdenum	3% Chromium 1% Molybdenum	3% Chromium 1% Molybdenum
Turbine Valves	0.14% Vanadium 1.1% Molybdenum	18% Chromium 8% Nickel Columbium stabilized	17% Chromium 14% Nickel 2% Molybdenum Columbium stabilized
Turbine Cylinder	0.14% Vanadium 1.1% Molybdenum	2¼% Chromium 1% Molybdenum	17% Chromium 14% Nickel 2% Molybdenum Columbium stabilized
Turbine Buckets	12% Chromium	13% Chromium	12% Chromium 5% Cobalt 3% Tungsten 0.15% Molybdenum

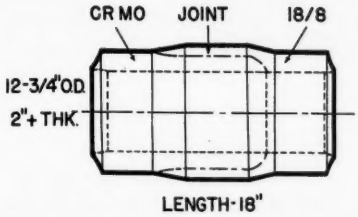


Fig. 10. Diagram of the Kelcaloy transition piece used to connect the austenitic steel of the boiler stop valves to the ferritic steel of the steam piping

tunnels enabled the use of forced cooling, by means of which the copper cross-section of the conductors was reduced from 12 to 6 million circular mils per phase, thus effecting a saving in cost and permitting the use of small, easily handled cables. Forced air is used to cool the pipes in Nos. 1 and 3 Tunnels. For Generator No. 2, the oil is circulated in the oilostatic pipe by a pump and gives up its heat in an oil-water heat exchanger. The forced cooling is required only in hot summer weather. Each generator has twenty-four 750,000-circular mil oilostatic cables, six in each 8-in. pipe.

The aluminum bus[2] was adopted for the transformer yard after a study showed considerable savings in its installation. A large portion of the savings lies in the use of the newly developed inert gas shielded arc system of welding in lieu of the usual bolted connections. This is the first installation ever made using inert gas shielded arc welding on outdoor buses of such heavy cross-section.

All auxiliary motors for one unit are supplied from the 2400 v auxiliary generator for that unit. Motors rated at 200 to 2000 hp are supplied at 2400 v; those between 25 and 200 hp at 440 v; while those below 25 hp are fed at 220 v. These latter motors and the station lighting are supplied by air cooled transformer load center units located throughout the station.

Totally enclosed motors have been used to the greatest extent practicable. In addition to the fan motors already mentioned, all motors for the coal handling system and boiler feed pumps, and the circulating pump motors of Nos. 3 and 4 Units, are totally enclosed.

Buildings

The architectural treatment of the buildings is simple and functional, with strong horizontal lines resulting from continuous rows of sash and glass block. At the permanent end of the turbine room there is a visitors' observation balcony which affords an outside view of the easterly end of the property and an inside view of the turbine room. The main entrance and lobby are at the permanent end of the service building. All the window sash are of aluminum and the principal entrance doors are of stainless steel. The turbine room roof is supported by arched girders rather than by the conventional open-truss construction. The temporary end is covered with corrugated asbestos sheets secured to steel girts. The coal handling buildings are enclosed with flat transite sheets.

Each of the four units which comprise the station has its own ventilating system which automatically controls the air temperature in the various parts of the main building. Filtered air is distributed to different locations and elevations in accordance with the heat losses in the various parts. Air washers provide evaporative cooling, for one unit only, when the proper relative humidity conditions prevail, and the heating coils warm the air in cold weather. The service building is ventilated in a similar manner. The systems are designed to operate with all windows closed and to maintain a slight positive pressure to keep dust and air out of the building.

Lighting

A high level of illumination is provided throughout the station in the belief that it will yield dividends in better operation, safety and general housekeeping. In this connection, special attention was given to the turbine room (Fig. 1). Combination incandescent-fluorescent units are mounted flush against the bottom flange of the roof beams to form a continuous fixture containing sixteen 500-watt incandescent lamps with control lenses and sixty-four 40-watt fluorescent tubes, about 10 kilowatts of lighting load per beam. Relamping and cleaning are readily accomplished from the top of the crane.

Conclusion

The objectives which the designers of Sewaren had was to attain a straightforward, simple arrangement which with central control would simplify operation and make for minimum manpower per kilowatt; a reasonably efficient cycle that would not be obsolescent at too early a date; and a simple building construction involving a minimum of maintenance throughout its life. These objectives, it is quite evident from this description, have been attained to a high degree. Sewaren will stand, without question, as an important milepost along the long, complex road of power station development.

In concluding this article we gratefully acknowledge the assistance of F. P. Fairchild, Chief Engineer, Electric Engineering Department, E. H. Snyder, H. Weisberg and P. A. Salmon, all of the Public Service Electric and Gas Co. in its preparation. The major part of the article is based on a paper presented by F. P. Fairchild at the Semi-annual Meeting of the ASME at San Francisco on July 1.

REFERENCES

(1) Cyclic Heating Test of Main Steam Piping Joints Between Ferritic and Austenitic Steels, Sewaren Generating Station, by H. Weisberg. A.S.M.E. Paper 48-A-87 presented at the 1948 Annual Meeting.

(2) Welded Aluminum Bus in Outdoor Transformer Yard of Sewaren Generating Station by D. M. Quick. Edison Electric Institute Bulletin, December 1948.

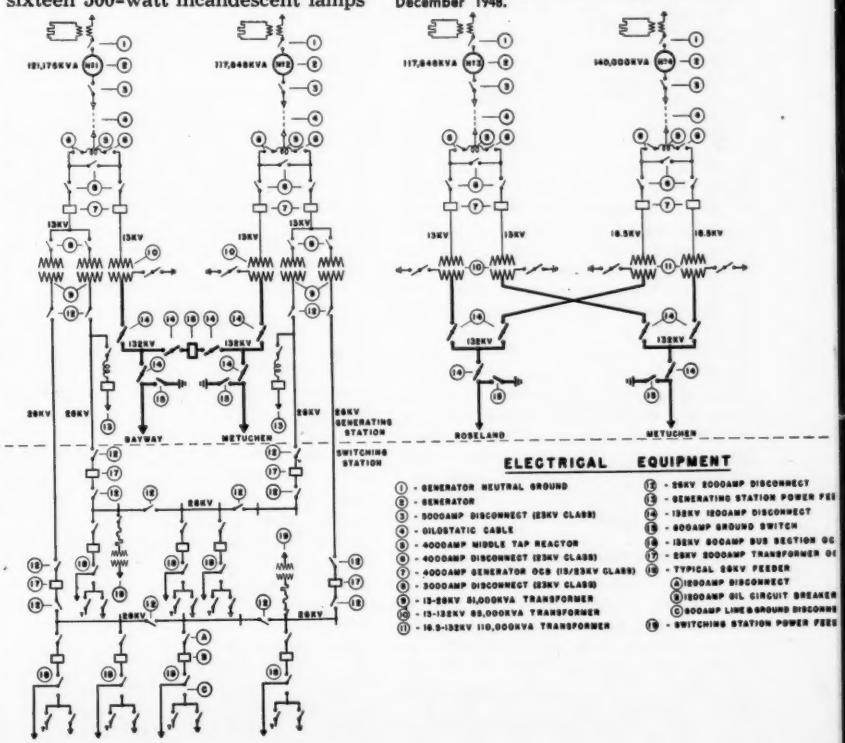


Fig. 11. Single line diagram of the electrical connections

Protective Coating Prevents Slag on Boiler Heating Surfaces

On a 430,000-lb-per-hr, 1215-psi, 920-F boiler, gas surfaces thoroughly cleaned and coated with lime slurry . . . Operated for a year after that with no appreciable deposits and no slag difficulties . . . Another boiler operated 16 months, after similar treatment, with no slag troubles . . . New boilers immune for several months . . . Then slag forms cumulatively, as sulfuric acid, manufactured from SO_3 in flue gas, increases dew point, causing ash in flue gas to stick to surfaces . . . Iron oxide is considered catalyst responsible for conversion of SO_2 into SO_3 . . . If metal surface exposed to flue gas can be reduced, less sulfuric acid formed . . . Lime slurry reduces exposed surfaces

By E. F. WALSH
Assistant Superintendent of Power Plants
The Narragansett Electric Co.

BOILERS DESIGNED and installed during the past eight years have been plagued more or less with objectional deposits accumulating on the superheater and economizer tubes. These deposits appear to become more troublesome with time, which would indicate a progressive effect of some nature toward the formation of slag.

As the operating pressure and total steam temperature has increased, another type of scale or slag, accumulating in the cooler passes of the boiler, has been observed which also has been found very troublesome and which cannot be removed without taking the boiler out of service.

The two types are:

(a) Deposits attributed to melted ash, and confined mostly to primary and secondary furnaces where temperatures for the most part will be above the melting point of the ash.

(b) Deposits in that part of the boiler where the temperature of gases has been lowered to a point beneath the fusion point of the ash, in which case another reason must be established for adhesion of the fly ash and scale formations on the heat transfer surfaces.

In case (a), slag formation will depend largely on the fusion point of the ash and the kind and quality of elements present. If the ash particles reach the sticky or agglomerate stage while in the furnace, there is a tendency to adhere to the tubes on impingement. The particles may or may not have been completely burned before deposition, or the ash has reached a state of complete oxidation.

How SO_3 Affects Slag Formation

It is well known nowadays that the flue gas from a boiler cannot be cooled below the dew point temperature without causing corrosion in economizers and air heaters. It has also been found, as the result of many investigations over many years (see references at end) that sulfur trioxide, SO_3, in the flue gas raises its dew point and has an important bearing on the formation of the slags of case (b).

Regardless of the form in which the sulfur may exist in the original fuel, it is all changed to sulfur dioxide (SO_2) gas under conditions of combustion, and remains thus until it reaches an environment causing its oxidation to sulfur trioxide (SO_3) and while sulfur dioxide in the presence of moisture is corrosive to an appreciable degree, it is more so after being oxidized to sulfur trioxide. This of course produces sulfuric acid with water, is hygroscopic, and raises the dew point in proportion to its concentration. The latter, as we will see later, becomes a major factor in corrosion and the building up of scale and stalagmitic formations in the after passes of the boilers.

Oxidation of SO_2 to SO_3 cannot take place above a temperature of about 2500 F. To bring about this oxidation reaction, it is reasonable to believe that the gases must come in contact with a catalytic agent, presumably on the metal or refractory surfaces.

How Slag Builds Up Gradually

During the investigation of economizer deposits by Rylands and Jenkinson[4] they observed a period of "immunity" with new boiler installations of from six to twelve months. During this time a film of scale is assumed to slowly build up on the surface of the metal, after which the action is very much accelerated. Various investigators have found this to be a coating of ferric sulfate or ferric oxide. It is assumed that infinitesimal amounts of SO_3 naturally present in the gas together with moisture are absorbed in the surfaces of the metal, even though the temperature is above the normal dew point. The sulfuric acid thus formed attacks the iron, forming ferrous sulfate, which later is oxidized to the ferric condition. The latter is not only hygroscopic in nature but is a powerful catalyst in the oxidation of SO_2 to SO_3, and from this point on, the local sulfuric acid "manufacture" becomes accelerated.

These experimental findings were reviewed in detail by the author in a paper on Some Aspects of the Cause and Prevention of Slag Deposits on the Heating Surface of Modern High Pressure Boilers, presented before the ASME Spring Meeting in New London, Conn., May, 1949.

Sulfur appears to be the principal offending element in the original ash in the fuel. The lower the sulfur content, the less sulfuric acid that can form and the final agglomerate mass called slag.

The published literature on the subject of slag deposits offered some encouragement in that if a means could be found to prevent or retard the formation of sulfur trioxide (SO_3), then a marked reduction in slag formation should result.

How a 1215-psi Boiler Was Protected

Our first experiments were conducted on a Combustion Engineering Co. boiler having a capacity of 430,000 lb of steam per hour and operating at 1215 psi and 920 F total temperature. This boiler was installed in January 1941 and has been fired with fuel oil and pulverized coal as combined fuels and with each fuel separately. The first year of operation of this boiler did not produce any serious operating conditions.

During the second year, slag conditions in the superheater became a serious problem. The superheater had to be hand lanced at frequent intervals to maintain sufficient draft for normal load. It was never possible to thoroughly clean the superheater while operating; thus the gas pressure drop across the superheater became excessive, making it extremely difficult to regulate the steam temperature by the by-pass damper.

Severe fouling of the superheater

occurred and continued to occur after about two months of operation following boiler overhaul and mechanical cleaning.

Slag in Two Layers

During the annual overhaul in 1946, samples of the slag deposits on the superheater tubes were removed for analysis. This slag was constructed of two layers. The inner layer or that portion adjacent to the tubes was the result of pulverized coal and fuel oil firing. The outer layer was definitely laid down during a period in which fuel oil was being burned and represented the type of deposit that can be expected from the present type of fuel oil and under firing conditions peculiar to the boiler in question.

The inner layer or that portion of the deposit nearest the tube surfaces was of a reddish nature and was 51.5 per cent soluble in water. The initial deformation temperature was 1900 F. Its analysis is given in the original paper.

The outside layer consisted of a hard black crystalline material and was 17.1 per cent soluble in water and its initial deformation temperature was 2150 F. Its analysis is also given in the original paper.

The increase in the initial deformation temperature of the outer portion of the slag is probably the result of a gradual increase in the gas temperature entering the superheater, due to slag accumulations on the furnace tubes. The higher the gas temperature, the greater the percentage of the total ash in the fuel that will be in a sticky state as it leaves the furnace, resulting in an accelerated accumulation once it begins to form on the metal surfaces.

A sample of the deposit in the gas flues between the air preheaters and induced draft fans was also analyzed. After igniting the deposit to a red heat it burned red in color due to the high iron content. Upon cooling and standing at room temperature in a humid atmosphere it became pasty and very sticky. This was due to the presence of anhydrous sulfuric acid absorbing moisture.

How Tubes Were Cleaned and Coated

Recognizing that the boiler apparently was immune to slag troubles during its first year of service, and that laboratory experiments had shown that if iron surfaces were protected with a lime deposit from SO_3, which is the principal factor in the formation of deposits, slag could be prevented from forming, the following program was decided upon.

During the annual overhaul period in 1947, the gas surfaces of the boiler in its entirety were thoroughly cleaned and coated with a lime slurry. Of extreme importance was that the metal surfaces were neutralized before applying the lime.

Soft water from a hot process softener having a pH value of not less than 11 and a PO_4 content of not less than 10 ppm, was sprayed on the slag for a period of about 8 hr. The slag absorbed sufficient water to dissolve the binder between the metal surfaces and the slag, making it easily removable. After all the slag was removed, the metal surfaces were washed with alkaline water until the acid in the pores of the metal was completely neutralized. The same treatment was given to the induced draft fans, air preheaters and duct work.

A lime slurry was then prepared by dissolving hydrated lime in water to a consistency that could be sprayed with a commercial paint gun. All metal surfaces were then thoroughly coated with lime.

No Slag Troubles for a Year

After completing the described treatment, the boiler was placed on the line and operated a year without any appreciable deposits. No slag difficulties were encountered during the year and the absence of the usual acid paste on the duct work was encouraging.

Another boiler, somewhat similar in design, was similarly prepared and treated after it had operated six months. This boiler has been in service sixteen months and to date there has been no evidence of any serious slag difficulties.

In addition to the lime coating on the metal surfaces, hydrated lime has been added to the coal on the conveyor belt at the rate of 50 lb to 400 tons of coal. There has been no evidence to date to indicate that the addition of lime to the fuel in this manner has had any marked effect on reducing slag formations.

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The top four industries in terms of capital investment in the United States are agriculture, railroads, public utilities and petroleum, says a Twentieth Century Fund study.

"Well, frankly, the only real difference between them is one carries a year's guarantee and the other only costs half as much—"

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity. Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, co-operate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Question No. 444

CAN WE USE A CADMIUM STORAGE BATTERY FOR A POWER PLANT?

WE ARE SEEKING information on the cadmium storage battery, which we understand is now being manufactured in the United States.

According to a recent article in *Reader's Digest,* this battery has been successfully used in Europe for many years, but has been withheld from the American market. This same article indicated that the process for the manufacture of this type of battery was brought to the United States by former members of the Armed Forces.

At present we are considering the installation of a power station battery and are anxious to obtain the latest information on application of the cadmium battery for this purpose.

Any comments which you might have, together with the name and address of the manufacturer, if available, would be appreciated.

St. Louis, Mo. W. J. S.

Question No. 445

WHAT TREATMENTS PREVENT SCALE AND CORROSION IN DRINKING WATER SYSTEMS?

IN MOST of the technical magazines, I have not found much information on water treatment as applied to prevention of scale and corrosion in supply systems where the water is to be used primarily for human consumption—that is, drinking, cooking, bottling and the like. I would appreciate Q & A readers' comments on what is done in such treatments and systems.

It has always seemed to me the expense of maintaining and replacing deteriorated sections of water supply systems must be high in factories, laundries, hotels, apartment houses, institutions and large office buildings where human beings consume large quantities of water.

In particular, I should like to have these questions answered:

1. What materials can be purchased on the open market, and used without infringing any patent rights, to prevent scale and corrosion in a system supplying water for human consumption?
2. Are there any easily obtainable materials for removing oxygen from such systems, to reduce corrosion?
3. Can sodium sulfite be used in such systems and, if so, what would be the maximum allowable concentration?
4. Can sodium tetraphosphate, available on the open market, be used in water treatment without patent infringement?

Toledo, Ohio J. W. B.

Editor's Note:—It is true there is not too much information on this subject in power engineering magazines but there is a tremendous amount of information available in the chemical, water supply and building fields. We have referred J. W. B. to some of it. But it would be interesting to have some comments on this subject from readers who have had experience with water supply systems and their problems.

Answer No. 439

ARE PISTON RODS EVER BOWED?

Yes, built that way, says McDermid

REGARDING THE request of C. L. M., for information concerning the low-pressure piston and rod assembly, which his repair shop found to be bowed or cambered. Modern machinists, used to the high-speed, light shafts of today, could easily be puzzled by the devices the older machine designers were forced to adopt to solve their problems arising from the weight of heavy parts, which perforce had to be supported at points camparatively widely separated. The piston and rod assembly is probably a good case in point.

The piston is heavy and must be supported by the rod from the crosshead at one end to the tail or perhaps distance piece slide, according to whether there are two cylinders arranged in tandem or not. In any case the points of support are quite a distance apart, and the assembly must sag in the center quite an appreciable amount. The observed "camber" is simply the designer's attempt to compensate for the sag which he cannot eliminate; so that when his parts are put in service, the natural sag brings them to as nearly a straight line as the designers are able to bring about by their estimating and experience with previous similar problems.

I have found uniflow steam engines built that way for exactly the reason given (and found their operating engineers badly worried when they found out the camber was there, without knowing why). Also one of the builders of world's record sizes of engines used to build a line of 42 by 54 in. gas engines that way.

These machines had two such cylinders in tandem on each end of the shaft—each double acting, and some of them carried huge blowing tub cylinders also on each piston assembly. The gas engine pistons and rods were hollow and water cooled, the water entering the assembly at the tail guide, and leaving it at the crosshead end. The assmblies were built, if memory serves, with a ⅜ in. camber, to compensate for the sag expected—and one concern bought five of these 900-ton prime movers, so it's a safe bet that the engineering design was carefully worked out by men of experience.

If further proof of the sag of heavy machine parts is desired, consider that of the main shaft of any heavy engine. It is a well known fact among well-trained erecting engineers that the two usual main bearings of an engine can be set at the same height, but the shaft level will never show "dead level" on a properly set shaft—it can only show an equal amount of sag toward the middle of the shaft when applied on each side of the usual flywheel.

In other words, even though the two bearings may be set at exactly the same height, the heavy shaft will be shown, by the delicate level, to be surely sagging between its two bearings. All the erector can do is to allow for this phenomenon, which is always present in any commercial shaft, however stiff and heavy it may be.

So, for the good of his nerves, my

suggestion to C. L. M. would be to check exact details with the engineering department of the manufacturer of his engine, if the company is still in existence; and, if this cannot be done, to accept the bow as he finds it, as an effort on the part of the designer to compensate for the sag he cannot eliminate.

Cincinnati, Ohio — H. B. McDERMID

Yes, says Nestor, and Cites His Experience

I WAS VERY MUCH interested in this question in the May issue about an apparently bent compressor piston rod, for I had a similar experience in 1909 while serving as chief operating engineer on a large gas compressing station for the Manufacturers Light & Heat Co. at Hundred, W. Va.

While dismantling one of the compressors on a 1000-hp Snow twin-tandem, double-acting, gas-engine-driven gas compressor unit, I discovered what I judged to be a bent compressor rod.

Upon taking the matter up with the company's chief engineer, I was told that these rods were purposely cambered in order to compensate for the weight of the heavy 18-in. cast-iron piston.

These rods were marked "top" as in your case and it seemed logical and reasonable that they should be turned in a camber, since the rods were about 12 ft long and were supported on the inboard end by a conventional type crosshead and on the outboard end by a tail guide crosshead. I suggest you write to the Worthington Pump & Machinery Corp., attention of H. E. Lehn, Buffalo, N.Y., who is familiar with these old engines, to get more data on your problem.

Shreveport, La. — W. E. NESTOR

Yes, says Dunbar, and Gives a Typical Case

WE HAVE, at times, run into this situation. The last case I recall was at a certain New England industrial power plant where they had a large, twin, tandem-compound, MacIntosh and Seymour engine directly connected to a large generator.

In this engine, the high-pressure cylinders were behind the low-pressure cylinders, separated by a separating or tie piece. Behind each high-pressure cylinder was a tail rod support with a tail rod crosshead. The piston rod from the main crosshead to the tail-rod crosshead was all in one piece and had been designed so that the deflection, when loaded with the weight of the high and low-pressure pistons, could be calculated; it was considered as a beam supported at both ends and loaded at these two points.

The piston rod was machined so that it would have a curve in it to compensate for the deflection; and so that, when installed in the engine with the high and low-pressure pistons in place, if the main and tail rod crossheads were adjusted in their central position, the piston rod throughout would be theoretically level.

These rods were marked "top" to facilitate correct installation.

Providence, R. I. — R. H. DUNBAR
Providence Engineering Works Corp.

Answer No. 440

HOW CAN HE COMPARE SIMPLEX AND DUPLEX PUMP EFFICIENCIES?

WHAT DATA would we have to obtain or assume, asked J.B. in the May issue, to compare the efficiencies of a simplex pump and a duplex pump in order to determine which should be used in a given case? Are curves plotted for such pumps, like those for centrifugal pumps; and, if so, what would such curves look like?

Knowing that this question involves the whole concept of pump duty, we asked for comments. Here are helpful ones by Messrs. Freyberg and Butcher.

Efficiency Rarely the Deciding Factor and Why

THE QUESTION of whether to use a simplex or a duplex pump for a given application is rarely, if ever, decided on an efficiency basis. The simplex pump is usually 10 per cent higher in overall efficiency than a duplex pump for the same service. Further economy can be obtained by using compound steam ends; but confining ourselves to a choice between a simple duplex and a simple simplex, so as not to branch out into a book-length dissertation on pump selections in general, the following factors are pertinent:

Simplex

- Minimum floor space
- Maximum economy
- Minimum number of parts
- Better for high vacuum conditions or hot water due to lower clearance losses
- Will not short stroke
- High efficiency — as high as 90% mechanical

Duplex

- Lower first cost
- Smoother flow characteristic
- Simpler parts
- Tendency to short stroke due to unequal packing friction
- Use where subject to neglect
- Use where roughly handled
- Use where exposed to bad weather
- Use where steam can be utilized for process after use in pumps

For a given set of service conditions, the simplex pump would have to have larger steam and water pistons or would have to travel at approximately twice the piston speed of the duplex pump. Any disadvantage of this kind to the simplex pump could be largely overcome by the use of a "duo-plex" pump, that is, two simplex pumps side by side.

Since these piston or plunger pumps are of the positive displacement type, capacity curves are essentially straight lines, increasing directly as piston speed increases. I say essentially because maximum mechanical efficiency is at lower speed and maximum steam efficiency is at higher speed, with little overall change within reasonable limits. Permissible piston speed varies with the liquid pumped, length of stroke, temperature, etc.; and figures of 30 to 80 ft per min are common, depending on the service. Lower speeds are required for pumping hot liquids.

Submission of formulas, when we are trying to keep the answer within as broad limits as the question, may not be of much service but J.B. may find this useful:

$$D = \frac{a \times P \times 12}{231} = 0.0408\ d^2P$$

where D = displacement of ONE double-acting plunger in gal per min
a = area of plunger in sq inches
d = diameter of plunger in inches
P = piston speed in ft per min

The data J.B. should obtain for an intelligent selection include: the capacity required (usually in gpm); liquid end pressure (psig); steam pressure (psig) and liquid pumped. Assuming the liquid is water and we wish to pump 100 gpm and 175 psi pressure with 125 psi steam, we would calculate, for a double-acting duplex pump, assuming a piston speed of 63 ft per min.

3.5^2: Piston Speed = d^2: gpm

3.5^2: 63 = d^2: 100

$$d = \sqrt{\frac{3.5^2 \times 100}{63}}$$

= 4.42 in. diameter liquid end

Nearest standard piston size would be 4½ in. diameter

Then: Area in sq in × Press. = Liquid load

$0.7854 \times 4.5^2 \times 175 = 2782.5$ lbs.

$$\text{Steam load} = \frac{\text{liquid load}}{\text{efficiency}} = \frac{2782.5}{0.65}$$

= 4280 lb.

$$\frac{\text{Steam load}}{\text{Pressure}} = \text{Area of steam piston}$$

$$\frac{4280}{125} = 0.7854\ d^2$$

d = 6.6 in

Nearest standard size larger than 6.6 in would be 7½ in. steam piston.

Use 7½ x 4½ x 10 pump at approximately 38 rpm.

A similar calculation could be made for a simplex pump starting with the formula 4.95^2: Piston Speed = d^2: gpm, and a standard size pump would be selected.

From that point, an evaluation of

(Continued on page 80)

How to Milk a Mouse

Oscar, the Gas Works Owl says there are several ways to do it . . . This time he is assisted by 3 sets of angel's wings

By JOHN RAVEN

ONE MORNING I was no little shocked, immediately after a most unpleasant session with my Boss over buying a pump and a non-return valve, to discover I was now behind the 8 ball in a matter of life and death. As usual, my information came from Oscar the Gas Works Owl. He had upset my bottle of India ink and by dipping his claws in the mess addressed me thusly:

i hear (declaimed the henscratches on my fuel pad) whil flying around that th gardian angls of ths plac r disgusted with a coupl of ur dum njuneers who think they can mistreat their machinry 4evr with ovrwrk nd wacks by a hamer wel u betr visit that big electric plant up th rivr but quik bcaws th 2 dun gys stand 2 hav their tikets puld f u dont go

This perilous situation, I went on to read, was largely my fault for having failed to get an O.K. on the new pump and valve. It seems I didn't know how to present my ideas in the right way.

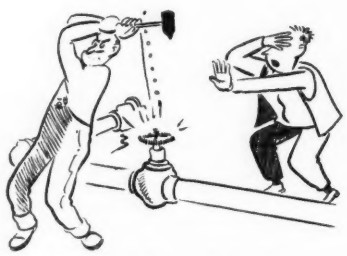
When u want somthng frm njuneers (the note concluded) u got 2 show them they got no magination remember ther is mor than 1 way 2 milk a mous urs n gratetud oscr the gas wrks oul

As I sneaked Oscar's note into the wastebasket, I reflected he might know of several ways to milk the 3,000 mice necessary to produce the 2 quarts of milk worth $20,000 reported in POWER GENERATION, but there wasn't even one way I could think of to make a Boss like mine say yes to spending 20c when he meant to say no. Take this morning's encounter for example. When I tried to explain how Fatso Fleming in Pump House No. 4 was revving up a steam turbine 400 rpm to carry the load, and that Mike Schultz in Boiler House No. 1 was habitually socking a bad 10-in. cast-iron non-return valve with a ball pein hammer to free it from sticking, was he satisfied with merely tearing up my requisitions? No. He finally opened his big mouth like an ash gate and bellowed:

"Stop arguing and get to hell back to work where you belong*!!!!"

He made it sound just like one word, and would certainly have added others equally big, but I stopped him effectively with two words of my own. I said, "Yes sir," and further showed my displeasure by leaving his office at once.

There is no use arguing with a Boss like that, so I put on my hat, got into my car, and drove two miles up the river road to the electric company's plant. It was a big white building, inhabited on the average by a quarter million Reddy Kilowatts per hour, with a spiked fence around it to keep the kilowatts from sneaking out every which way, and had a watchman at the gate.



. . . loosening a stuck valve a la Mike Schultz

"No visitors today," said the watchman. "We had an oil switch blow up early this morning and kill three men. What d'you want?"

I didn't know what I wanted, so I surprised him by leaning over and whispering into his ear the simple truth:

"Oscar sent me."

"Oh!" said the watchman. Dazed by my truthfulness, he opened the gate.

I went to the switch house and followed the strings of dormant fire hose that led through the fatal room. Before the explosion, the high walls that faced the battery of oil switches on three sides had been finished in spotless white, the floor in pearl gray. Today I might have been inside a brown-hued, sooty cave, with ghostly daylight seeping in like dishwater through the smoke stained window panes.

. . . equipment needed for mouse milking

. . . the handwriting on the switch house wall

There were several men in the room. All of them were just standing there in silence, staring up at one of the high walls. I looked up too, and what I saw made me feel quite uncomfortable inside. In fact, I could feel live caterpillars, or maybe it was just apprehension, start to crawl coldly around in my breakfast.

Three figures were visible on the wall in a kind of mural, drawn clearly but softly in the brown charcoal of the oil smoke. Three figures I will never forget, a man, a woman, and a child, each of them equipped with the strong pure wings I had first seen long ago, in angels' pictures of my childhood. Now I knew the effectiveness of seeing; engineers without imagination, like me, must be shown, not merely told, of the need for action.

I went straight back to the Boss' office, wishing I had a picture of that scene in the switch house, but the early edition of the afternoon paper, carrying the full story, was almost as good. I threw the paper on his desk and gave him a few minutes to digest it. Then I commented sadly that we must expect the same tragic occurrence in the gas works; the place was dead ripe for it.

"In fact," I added mournfully, "It's only a matter of time, maybe minutes, before we lose Fatso and Mike. Day in and day out, they're giving their machinery a terrible beating to carry the load. They insist the only alternative is to buy new equipment. I can't do a thing with them."

The Boss laid down the newspaper and I could see the color commence to climb up his neck. He made me think of an old-time gasoline pump.

"The idiots!" His big voice was beginning to bellow. "I'll do something with them. Don't they know accidents will give the works a bad name?"

He picked up the telephone, but before calling Fatso and Mike, took a final cut at me.

"As for you," he warned, "Don't ever let dumb engineers get you over a barrel like this again. You understand? Now get out,—and start ordering what those two need."

"No sir, yes sir," I agreed happily.

AUSTRALIA PLANS NEW HYDRO-IRRIGATION SCHEME

THE AUSTRALIAN Federal Government has decided to set up a special Commission to carry out Australia's biggest single public project. It is a huge hydro-irrigation scheme to use the waters of the Snowy River. This regular, snow-fed river rises in the Australian Alps and flows southeast into the Pacific. Each year 1,699,000 acre feet of water rush useless to the sea. And this in a country where dry spells are frequent and electric power precious. The States of Victoria and New South Wales each had claims on the waters of the Snowy catchment area, a mountainous geographical no-man's-land between the two states. The Federal Government has now stepped in and secured agreement for the first step in a possible £A166,000,000 conservation scheme which has some of the elements of an Australian Tennessee Valley Authority.

The huge power potential of the completed scheme may make Australia a major center for the development of atomic power. Sir Henry Tizzard, chief scientist adviser to the British Government, showed keen interest in the scheme during his recent visit to Australia.

The Australian Alps are a tangle of ranges in the vicinity of the eastern borderland between Victoria and New South Wales. Among these flat-topped mountains more than 1,250,000 acres lie under snow for six months each year. In a recent report two Federal officers called the area "a costless reservoir of snow." This reservoir feeds Australia's greatest river, the Murray, and its great tributary, the Murrumbidgee.

For years Victorians have fought for a scheme to divert the Snowy River into the Murray and increase irrigation and power potential in a valley already famous for its irrigation settlements. The people of New South Wales, on the other hand, have always wanted more water for power and increased irrigation in the Murrumbidgee Valley. The new, Federal-sponsored compromise agreement, will divert two-thirds of the Upper Snowy (above Jindabyne) into the Murrumbidgee, leaving decision on the other one-third for the present. A technical committee will report on the disputed one-third by the middle of 1949. Meanwhile, a start can be made with the diversion of the undisputed two-thirds.

The agreed first stage, involving two-thirds of the Snowy catchment waters, will provide over 600,000 acre feet of irrigation water, generate and transmit 720,000 kilowatts of electric power at a generating cost of about £A70 a kilowatt. It includes four major dams, 42 miles of tunnel, 170 miles of racelines and seven power stations.

Experts estimate that the agreed first stage will take at least eight years.

USE OF EXHAUST STEAM SAVES 800 TONS OF COAL ANNUALLY

By JAMES O. GIBBONS

THE NECESSITIES of the recent war, and current shortages have caused the British Ministry of Fuel and Power to do everything possible to encourage the most economical use of available fuel supplies, and they have from time to time published descriptions of plants which have been modified in accordance with the recommendations of their engineers with gratifying results.

It should of course be kept in mind that conditions made it imperative to do the best possible under adverse conditions, and any question of replacing equipment which could reasonably be made to do, was not to be considered. At the same time there is no doubt that there are a large number of our own plants which would be greatly benefited by the application of the same kind of treatment, even if some of the solutions may not be entirely in accordance with the best American practice, but then again how many of our own plants are, with less excuse.

The accompanying diagrams indicate the changes made in a Forge Shop and the operating economies resulting from the installation of a minimum of new equipment. It is stated that the plant was consuming 40 tons of fuel a week during the winter months and the boiler was overloaded.

Figure 1 shows the general steam consumption before the changes were made, and Fig. 2 the consumption after.

In this factory fourteen 10 cwt hammers were installed in two shops, and the re-heating furnaces could maintain seven hammers in constant use, with a working week of 58 hours.

It will be seen that 700 lb of live steam were wasted, and the heating coils were fed with steam at 10 psi with 2000 lb of condensate going to the drain. The feedwater tank was not insulated and the boiler-feed pump exhaust wasted.

It is stated that with the space heating load carried mainly on exhaust steam and the hammers working efficiently due to dry and uniform steam, the annual saving in fuel was 800 tons and the capital outlay of pounds sterling 1,904, or about $7,600, recovered in only fourteen months.

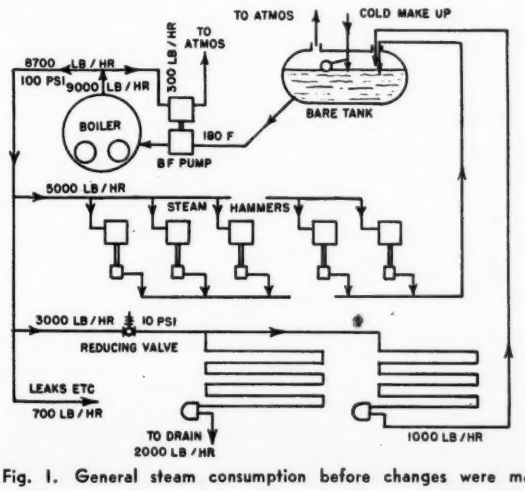


Fig. 1. General steam consumption before changes were made

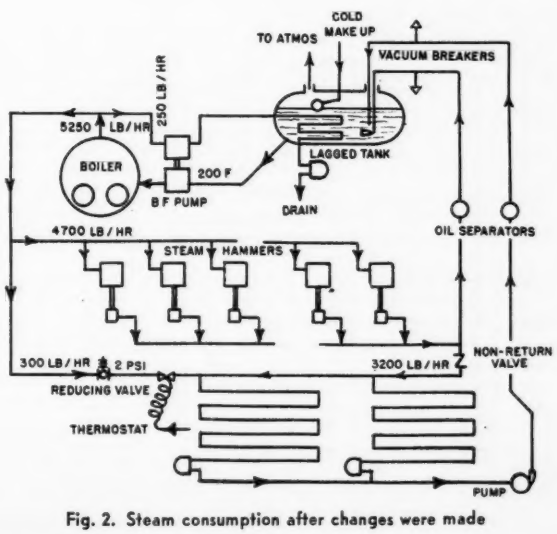


Fig. 2. Steam consumption after changes were made

What Determines Maximum Boiler Feed Pump Discharge Pressure?

By MARVIN M. PERSINGER

SOME TIME ago an engineer inquired in the Q & A section of *Power Generation* (Question No. 424, August 1948 issue) why it is that some power plant designers, in calculating boiler feed pump capacities, provide pumps for a discharge pressure high enough to pump full capacity into a boiler while all the safety valves blow.

The question might also be asked thus: Why are boiler feed pumps designed with sufficient head to lift the safety valves?

On the original question, much good comment from a number of engineers was published but much of it was fairly general and the writer would like to amplify it with some more specific comments.

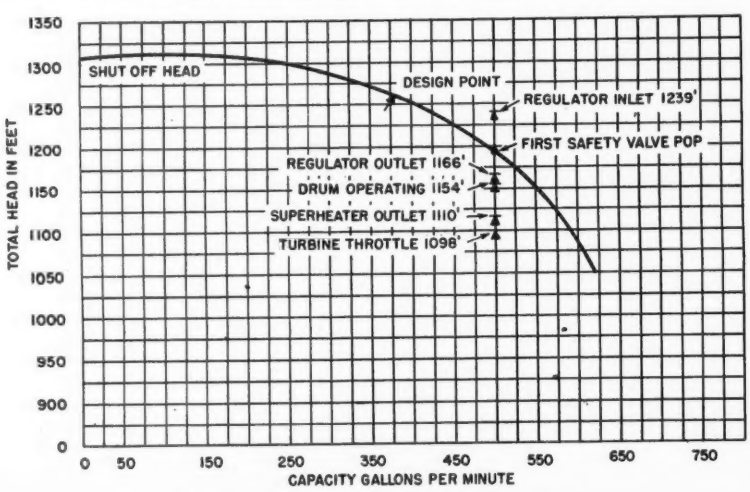
Boiler feed pumps are usually designed with sufficient head to lift the boiler safety valves should the operator wish to do so; however, this is not directly an influencing factor in arriving at the necessary pressure. The boiler feed pump shut-off head depends upon the particular installation in question, and actually stems from the desired turbine throttle pressure.

For example, let us assume an installation requiring 150,000 lb per hr of steam at 450 psi, 750 F. Such an installation would probably have 455 psi at superheater outlet header and full load superheater pressure drop would probably be about 18 psi. This will give a drum operating pressure of 473 psi. If we allow the minimum 3 per cent required by the safety valves to insure tightness, the minimum design pressure of the boiler drum will have to be 490 psi. This will, of course, establish the first drum safety valve at 490 psi.

Now, the feedwater regulator manufacturer on a job of this size, would ask for about 30 psi pressure drop. The designer would more than likely establish the feedwater regulator outlet pressure at least 5 psi over drum operating pressure, provided the unit did not have an economizer. With short piping, one closed heater, one gate valve, and one check valve, plus the boiler feed stop and check, the minimum feed line pressure drop would be 8-12 psi. Static would be almost cancelled by dearator elevation. When we compile results of all influencing factors, we have:

Boiler capacity	150,000 lb per hr
Max. design pressure	490 psi
Drum operating pressure	473 psi
Superheater outlet pressure	455 psi
Turbine Throttle pressure	450 psi
Popping pressure of drum low set valve	490 psi
Feed water temperature	240 F.
Feed pump discharge head at full load condition	516 psi
Drum operating pressure	473 psi
Regulator pressure drop	30 psi
Excess of drum pressure	5 psi
Feed line pressure drop	8 psi
	516 psi

For the particular head and capacity combination involved, the head-capacity curve of the feed pump would more than likely be relatively flat. A typical curve of this kind is shown. This is desirable from the standpoint of heater and feed line equipment investment as well as power consumption at partial loads. The difference between full load and shut-off head of such a pump might vary between 20 and 50 psi, but would probably be nearer the lower figure. If we use 20 psi, we have a shut-off head of 536 psi, which is considerably above the safety valve set pressure. The capacity of 375 gpm is maximum and not normal operating. The excess of course, is to take care of emergencies.



Typical head-capacity curve for a boiler feed pump

Answer No. 440

HOW CAN HE COMPARE SIMPLEX AND DUPLEX PUMP EFFICIENCIES?

(Continued from page 77)

steam consumption and maintenance cost would have to be balanced against capitalized cost as an economy study and the proper decision made as to which should be purchased.

Pleasantville, N. Y. R. H. FREYBERG

Express Efficiency by Input to Output in Foot Pounds

THE MECHANICAL EFFICIENCY of any pump is a matter of the ratio of input to output, a simple thing of itself but frequently difficult to measure.

The common denominator for the two things is usually the foot pound.

Input may be measured in pounds of steam per hour at a given temperature, a given pressure and a certain quality. By the use of steam tables, this can be converted to Btu and, in turn, Btu can be converted to foot pounds.

It makes no difference whether a steam driven pump is a simplex or duplex direct-acting unit or a crank and flywheel type; the above definition of efficiency is applicable.

If the pump is electric-motor-driven, the input to the motor can be ascertained with a wattmeter and converted to foot pounds.

For water works pumps, the efficiency is usually considered "from wire to water," though pump manufacturers would deduct the energy required to operate the motor alone from the total input.

The pressure at the pump delivery side should be converted into feet head. To this should be added the suction lift to the center of the suction. This sum, multiplied by the weight of liquid handled (gallons multiplied by weight per gallon) will give the output in foot pounds.

Reciprocating pump characteristics are not indicated by curves similar to centrifugal pumps, because of the difference in the way they operate.

If an accurately calibrated meter or tank of known capacity is not available for measuring the output of the pump at constant head, it is difficult to measure the amount of liquid pumped.

Steam consumption is also difficult to measure, except under special test conditions.

For the above reasons, the manufacturer's efficiency rating is generally used in making rough calculations.

Piney River, Va. IRA A. BUTCHER

ATOMICS

Nuclear Reactors for Power*

THE TWO questions most frequently asked when atomic energy is discussed are, 1. When can we expect to see atomic power plants in operation, and, 2. Is there enough fissionable material in the world to make atomic energy an important factor in our future power supply?

There is disagreement among the experts regarding the latter question but the Atomic Energy Commission has gone on record in answering the first question with some degree of certainty. The Commission expects to have a full-scale central station type atomic power plant running by 1957—a plant that will not only answer questions concerning the technical feasibility of such plants but also their economic feasibility.

Because of the great military importance of atomic energy both from the standpoint of weapons and power for ships and aircraft, atomic power plants will be developed regardless of cost or future uranium supply. The pressure by the Navy and Air Forces upon the Atomic Energy Commission is one of the most stimulating factors in the development of atomic reactors for power today.

At the present time the AEC has four major reactor projects under way. These are as follows:

1. A materials testing reactor which will be used in studies of materials to be employed in building other nuclear reactors. This will be built in Idaho.

2. A Navy reactor designed as a land-based prototype reactor for use in the propulsion of naval vessels of appropriate type.

3. An experimental "breeder" reactor designed to operate with extremely high energy neutrons. This will be used to explore further the possibilities of breeding, that is, producing more fissionable material than is consumed in the operation of the reactor and also of power production. This reactor, sometimes called the Zinn pile, will be built at the Argonne National Laboratory near Chicago. This pile will be practically a slow acting atomic bomb. It will use a highly enriched U-235 fuel and will operate like a bomb, using fast, high energy neutrons. This reactor will operate at an extremely high temperature—2000 F or more.

4. An experimental "breeder" reactor is to be constructed at General Electric's Knolls Atomic Power Laboratory near Schenectady. This pile will operate with neutrons of intermediate energy. Many physicists feel that only a bomb type reactor can breed successfully. The Knolls will test this out. It will attempt to breed by the use of only slightly enriched fuel and medium energy neutrons. While this pile will run cooler than the Zinn pile, it will take out substantial amounts of power by the circulation of a liquid metal heat exchange medium.

In general, there are two types of nuclear reactors, the heterogeneous type in which the fissionable material is localized in lumps or rods forming a lattice structure within a moderating material and the homogeneous type, in which the fissionable material is uniformly distributed throughout the active portion of the reactor. An example of this type is the Los Alamos "water boiler" as it is called. This is a small unit containing about 2½ lb of U-235 in the form of a soluble salt of enriched uranium dissolved in light water.

Most of the reactors that have been built so far, have been of the heterogeneous type but the idea of developing a homogeneous reactor has been studied and re-studied for many years and if it could be brought to practical success it would be possible to have the nuclear reaction, the removal of energy, and the reprocessing of the nuclear fuel all together in one extended unit.

The present reactor development program should tell whether it is technically possible in a small scale plant to produce electrical energy from a nuclear reactor. If the results are favorable, then it will be possible to design a large scale reactor for the practical generation of electrical energy and in the course of this development it should become clear whether this possibility is economically feasible.

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* This article is an abstract of an article in the June issue of the new ATOMICS magazine.

As announced in the June issue of Power Generation, the ATOMICS section which has appeared as a section of Power Plant Engineering and Power Generation since October 1945, is now being issued as a new, separate, publication.

The new ATOMICS represents a greatly expanded service to those who are interested in the theory and applications of atomic energy. It will keep readers abreast with what is happening in the field of atomic power development, in the industrial applications of radioactive isotopes and in the use of nuclear energy in medicine, biology and agriculture. The June issue, for example, in addition to the article abstracted on this page, has an article on the use of Radioactive tracers in corrosion studies, the first installment of a complete course in Nuclear Power Engineering, as well as other items of general interest from the Atomic world.

If you are interested in seeing this new magazine regularly, send in the attached coupon for a free copy of the June issue. It will be published monthly, and as has been true of the articles which have appeared in the ATOMICS section of Power Generation, the articles will be kept on a practical understandable level.

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ELECTRICAL

Frequency Relays Disconnect Synchronous Motors Under High Speed Reclosure

By A. J. MEYERS,
Utilities Engineer, Shell Oil Company, Inc., Norco, La.

SHELL OIL COMPANY, Incorporated's Norco Refinery, located on the Missisippi River approximately 25 miles above New Orleans, receives its purchased power supply through a 110/13.8 kv substation. The 110 kv line serving this substation is the connecting link between the New Orleans area generating stations and the generating and transmission systems in a number of southeastern and southwestern states. Outages on this 110 kv line, caused by temporary disturbances such as lightning flashovers, have amounted to some 45 to 50 per year. These interruptions were not only troublesome to the refinery but the intervals required to secure OCB reclosure with the original relaying devices were causing upsets in load balance between the New Orleans and interconnected generating stations.

As a step that would be of mutual advantage in improving continuity of operations at the refinery and on the power company's transmission system, the Louisiana Power and Light Co. proposed installation of equipment to permit high speed reclosure of switch-gear at their substations on the 110 kv interconnecting high line. The proposed installation involved the use of directional-carrier distance relaying equipment which accomplishes reclosure in 20 cycles. Application of high speed reclosure presented the problem of providing protection for synchronous motors at the refinery.

Three relatively small generators are used at Norco Refinery to supply part of the total plant demand but these units are not operated in parallel with the purchased power circuit. Double throw oil circuit breakers are used to switch back and forth between the two source buses to maintain the optimum balance in loading.

Reclosure Affects Synchronous Motor Operation

The Refinery feeders, usually supplied from the purchased power bus, serve four synchronous motors equipped with oil switch starters. High speed reclosure of a circuit in 20 cycles results in only a slightly noticeable flicker in lighting equipment and about a 12 per cent reduction in speed of those induction motors that stay on the line. Synchronous motors, however, lose sufficient speed to cause stalling or pull-out when the supply circuit is re-energized at high speed. This stalling would cause excessive mechanical strain and overheating of equipment and could not be tolerated as a normal condition.

Before the high-speed reclosure equipment could be employed, it was necessary to devise some means for disconnecting the synchronous motors within 1/3 second or less. Conventional voltage, current or frequency relays were not capable of inaugurating relaying sequence in sufficient time to disconnect the motors. Special relays heretofore capable of performing this function were too expensive and unreliable to warrant their application on this job.

New Type Frequency Relay Offers Solution

Louisiana Power and Light Company engineers, working on the problem with General Electric engineers, recognized that the recently developed type "CFF" General Electric frequency relay made available an inexpensive and reliable device which could be adapted for this special job. This relay is adjustable over a narrow frequency range and can be made to operate in approximately ½ cycle or 1/120th second following frequency change beyond its setting. The extremely high sensitivity makes it necessary to interpose an adjustable time delay to secure the desired operating characteristics and to prevent faulty operations due to jarring or shocks. The adjustable time delay is secured by use of a resistor- capacitor combination in conjunction with a conventional direct current

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When the Louisiana Power and Light Co. proposed to install high-speed reclosing switchgear to reduce the number of outages it became necessary for the electrical engineers of the Shell Oil Co. refinery at Norco to devise means to disconnect their synchronous motors at the time that the reclosing equipment came into operation. How this was done is explained in this article by A. J. Meyers, Utilities Engineer of the Shell Oil Co. at the Norco Refinery. The problem was difficult because the motors had to be disconnected within 1/3 of a second or less. The job was successfully accomplished by the use of a new General Electric frequency relay which can be made to operate in approximately ½ cycle or 1/120 of a second following a frequency change beyond its setting.

A. J. Meyers, who wrote this interesting article, is a native of New Orleans, La. He received his bachelor of Engineering degree from Tulane University in 1930. Joining the Shell Oil Co. at the Norco Refinery in 1931 as junior draftsman, in 1932 he was appointed Assistant Storekeeper, and in 1935 was transferred to the Industrial Engineering Department as technical assistant. In 1939, he was transferred to Shell's Wood River Refinery as an industrial engineer and in 1943 was promoted to senior utilities engineer. In July 1946 he returned to the Norco Refinery as Utilities Engineer, the position he now holds.

operated auxiliary relay. The capacitor is connected across the operating coil of the auxiliary relay and an adjustable resistor is connected in series with this combination. The accompanying one line diagram shows, schematically, the connections of the frequency and auxiliary relays. The resistor limits the rate of current flow in the circuit and, since current must be stored in the capacitor before the voltage across the operating coil of the relay can rise, a time delay in its operation is encountered.

The Power Company engineers conducted tests with an automatic oscillograph which indicated that frequency on this circuit dropped from 60 to 59.5 cycles within approximately four cycles following trip of the source breakers. Tests also indicated that approximately seven cycles were required to open the oil switch to the synchronous motor following de-energization of its holding coil. It was then decided to set the frequency relay at 59.5

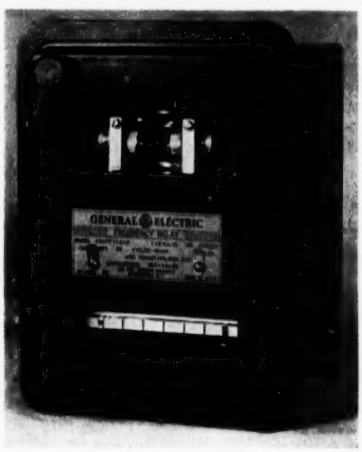


Fig. 1 The frequency relay which disconnects the synchronous motors when the reclosing switchgear operates

cycles operating point and to set the operating time of the interposing time delay at approximately five cycles. These settings were calculated to give an over-all operating sequence as follows:

(a) Time from opening source OCB until frequency falls to 59.9 cycles	4 C
(b) Operating time of CFF	½ - 1 C
(c) Operating time of auxiliary relays (HGA-14D R12HGA)	5 C
(d) Operating time of Motor Switch	7 C
Approximate Total Time	17 C
Line Outage Time	20 C
Approximate Margin	3 C

In laying out the frequency relay application consideration was given

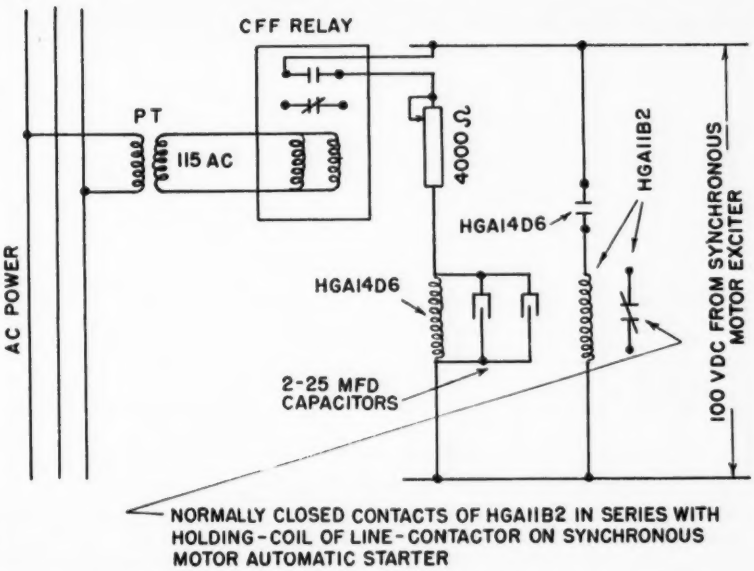


Fig. 2 Schematic connections of the frequency relay used to protect the synchronous motors with high speed reclosure of circuits

to the use of one centrally located frequency relay which would operate through auxiliary relays to disconnect all synchronous motors. However, because of physical separation plus the fact that the central frequency relay would cause indiscriminate tripping of all synchronous motors regardless of source, it was decided to install a frequency relay on each of the four synchronous motors.

In normal application employing high-speed reclosure it is necessary to provide time delay undervoltage device on induction motor starters if these motors are expected to "ride through" the instantaneous outages. This type application assures that the starter will not open during such disturbances and motor quickly resumes normal speed following reclosure of the source OCB's.

Upon examination of oscillograms made prior to the frequency relay installations, it was noted that voltage on the circuit was about 50 per cent normal at the end of 20 cycles after trip-out at source, if synchronous motors were in operation. It was also noted that voltage fell approximately 75 per cent at the end of 20 cycles if only the induction motors were in operation. The increased voltage due to "regenerative effect of the synchronous motors was considered worthy of investigation with regard to the attendant advantage of causing induction motors to hold in, eliminating the need for time delay undervoltage devices on the individual induction motors.

Investigation proved that the regenerative effect of all motors was sufficient to cause almost all starters to hold in, if synchronous motors were in operation at time of outages. When synchronous motors were not operating it was found that the regenerative effect of induction motors alone was not sufficient to cause all motor starters to hold in, only approximately 75 per cent holding under this condition. These tests indicated that the application of high-speed reclosure plus frequency relaying would minimize the need for time delay undervoltage devices on induction motors since chances were good that they would ride through.

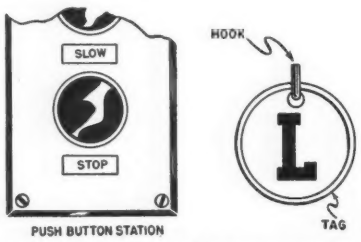
Frequency relaying on the synchronous motors and the high speed reclosure features on the source oil circuit breakers were put into operation at the same time. Results have been gratifying. Synchronous motors are disconnected successfully and only a small percentage of induction motors is affected by the temporary interruptions, particularly if synchronous motors are in operation at the time of interruption. The synchronous motors normally remain on the line approximately 17 cycles following the source breaker operation and supply sufficient regenerative effect to hold the induction motor starters. Only about three cycles remaining time is encountered following opening of synchronous motor switch until source is restored.

Use of high-speed reclosure equipment on transmission and distribution systems has become general practice with most utility companies where attendant advantages to customer service justifies its application. Because of the added advantage of minimizing upset due to temporary power outages it is felt, therefore, that this rather unique adaptation of the frequency relay warrants consideration whenever circumstances involve synchronous motor protection under high-speed source reclosure. Each application will, of course, constitute a separate problem depending on system characteristics.

FAN SPEED INDICATOR

By HERBERT BOUTON

ON A TWO-SPEED, alternating-current, motor-driven ventilating fan, equipped with push button starters, where no speed indicating lamps are provided, the uncertainty as to whether the fan is on low or high speed can readily be removed. This merely entails providing a hook near the control button station on which a metal



Hang a tag near control button, says Bouton, if there are no speed indicating lamps, to show whether fan is on high or low speed

tag may be hung. The tag should bear the letter "L" on one side and the letter "H" on the other, and should be sufficiently large enough to be easily seen. The tag should always display the letter indicating the fan speed.

* * *

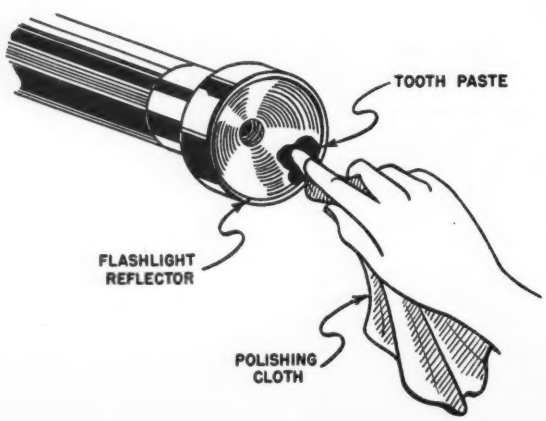
A new and novel soldering iron which requires no electric current or external heat utilizes a chemical cartridge about the size of a small flashlight battery. When the cartridge is fired, the iron attains the work temperature in five seconds and maintain heat for ten minutes.

* * *

NEW USE FOR TOOTH PASTE

TOOTH PASTE, whether of one of the varieties that make teeth several shades whiter, remove smoker's smudge, or just clean teeth, is handy and efficient for cleaning watch crystals and lenses and reflectors of flashlights. When used for these purposes, less water is needed than when employed to brush teeth.

Baltimore, Md. THOMAS TRAIL



Tooth paste good for cleaning reflectors

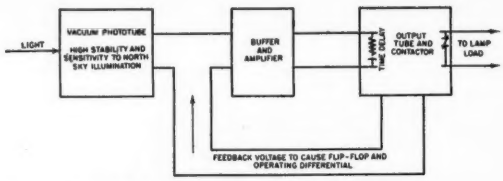


Fig. 1. Simplified diagram of aircraft light control circuit

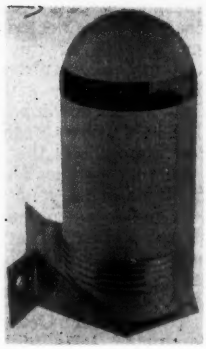


Fig. 2. View of aircraft light control unit as mounted on the structure

CONTROL OF AIRCRAFT WARNING LIGHTS ON STACKS

IN THE January 1948 issue, under Question No. 405, a reader called for help in obtaining the best possible method of installing night warning systems on his power plant stack. His plant was quite close to an airport and they used four 1500-watt flood lamps focused on the stack to illuminate it for the benefit of airplane pilots. He asked what other engineers had done in such situations.

Answers published in the April and May 1948 issues brought out, that the first thing you have to do is consult the Civil Aeronautics Administration which has complete jurisdiction over the lighting of stacks for airplane warning. Joseph E. Sullivant gave some of the detailed requirements of the CAA and suggested several types and makes of light fixtures and disconnecting and lowering hangers, in which the lamps can be mounted for easy replacement. Other readers brought up the matter of automatic control of these lights, pointing out among other things to turn them on and off. One of the automatic controls referred to was the Fisher-Pierce photoelectric aircraft obstruction light control shown in accompanying illustrations, but not previously described.

The idea of automatic control for obstruction lighting is by no means new but this particular control has some new features for control of obstruction lights on stacks and also, at a somewhat lower operating level, for control of street and yard lights. This photoelectric control is actuated by natural sky illumination rather than by a time clock or by manual control.

It consists of a two-stage photorelay, mounted on the stack or other structure and oriented on the supporting surface so that the phototube "looks" at the north sky. The photorelay is connected in a factory-adjusted circuit so that the relay turns on the obstruction lights at 35 foot-candles of natural light and turns them off at 55 foot-candles. Provision is made for readjustment of the turn-on point from 30 to 40 foot-candles. Differential between turn-on and turn-off is fixed at approximately 20-foot candles for standard models.

The phototube, through suitable amplifier circuits, actuates an output tube and contactor to control the power supply to the lamps at the top of the stack.

Built-in relay is designed to switch up to 500 watts of incandescent lamp load at 115 or 230 v a-c. For loads up to 3000 watts, a separate contactor can be supplied. The circuit has fixed time relay for turn-off of about 15 sec, to stop cycling, or turn-off from short duration light flashes such as lighting, rotating aircraft beacons or similar light transients. In the primary side of the transformer is a 10-amp quick-blow fuse to give maximum protection against possible induced voltage transients from lighting. The control lights are turned on in the event of any circuit failure. Special models are available for 25-cycle and for 230-v operation.

This control was originally developed for street lighting and the manufacturer states that many of them have been in service since late 1945 under severe conditions.

A simple, heavily galvanized mounting is supplied to which all wiring is connected. The rest of the control is mounted on a chassis which is then plugged in and the enclosure screwed in place.

ASME Holds 1949 Semi-Annual Meeting at San Francisco

WITH A DIVERSIFIED program of technical papers, interesting inspection trips, addresses on national and world problems involving the engineer, and a number of social events, the ASME held its 1949 Semi-Annual Meeting at the University of California Extension Building, San Francisco, Calif., from June 27 to July 1.

California Steam Power Expansion

Steam power facilities are being expanded so rapidly in California that by 1951 almost half the state's power will be steam generated. Steam power expansion in Southern California was reviewed by W. L. Chadwick of the Southern California Edison Co., who pointed out that natural gas and oil have been used exclusively as fuel for producing steam power, although possible future use of coal has been provided for. Outdoor type plants have been used and in some cases it has been necessary to design for minimum time load pickup.

The steam power expansion program in Northern California is being undertaken principally by Pacific Gas & Electric Co. and to a lesser extent by U. S. Bureau of Reclamation, as reviewed by C. C. Whelchel and W. R. Johnson of Pacific Gas & Electric Co. Here, too, increased importance for fuel burning plants was pointed out and details were given. As integration and growth of the system continues, the authors expect the need for quick pickup steam stations and multpile boiler per turbine installations probably will decline.

Design of Sewaren Generating Station and No. 1 Unit at Essex Station of Public Service Electric & Gas Co. (N.J.) was given by F. P. Fairchild of that company. This paper is abstracted in considerable detail elsewhere in this issue. Stanford Neal of GE Company and V. S. Renton of PSE & G Co. presented papers on operating characteristics and heat rate test results of the 100,000 kw Essex turbine generator.

Feedwater Studies

As usual there was much interest in boiler feedwater studies. Feedwater treatment during early operation of steam electric stations was discussed by R. C. Alexander of the Harbor Steam Plant of the Bureau of Power & Light, City of Los Angeles. In preparing the station for service, usually the most important single consideration is maintenance of minimum corrosion of the feedwater system equipment and disposal of the corrosion by-products that lodge in the feedwater heaters and the boilers. Proper initial cleaning of the equipment is paramount. The factors leading to corrosion were covered in detail. Sampling and frequency of control tests were discussed, also inspection of equipment.

In another paper, Mr. Alexander, together with J. K. Rummel, of the Sheppard T. Powell Chemical Engineering Staff, presented a paper on the quality of steam condensate as related to sodium sulphite in the boiler water. They concluded that increase in sodium sulphite beyond certain limits was found to lower appreciably the pH and to raise the conductivity of the condensed steam.

Another important problem in West Coast plants is that of marine fouling. A summary of four papers on this subject was given by H. E. White, Stone & Webster Engineering Corp.

Grand Coulee Pumping Plant

History and development of the Grand Coulee pumping plant were reviewed in detail by E. B. Moses, Engineer, U. S. Bureau of Reclamation. The Grand Coulee pumping plant has been the subject of an intensive and extensive hydraulic research, some of the results of which, as conducted at the California Institute of Technology for the Bureau of Reclamation, have already been published. Carl Blom, Chief Engineer of Byron Jackson Co., in a paper Development of the Hydraulic Design for the Grand Coulee Pumps, presented the results of that company's continued experimental research from 1943 to 1946.

Mechanical design and construction of the Grand Coulee pumps was discussed by Ira M. White, Manager of Engineering, The Pelton Water Wheel Co. Development of a pump capable of lifting 1350 cu ft of water per second against a head of 310 ft has required extensive development. Five different types of pump casings have been studied. A careful comparison of the good features of all has led to the ultimate selection of a 6-vane diffusor type of pump.

Burning Wood Fuel

Otto de Lorenzi of Combustion Engineering-Superheater, Inc., reviewed use of the 2-stage furnace, generally accepted as standard for "hog fuel;" showed how, recently, large scale experimental installations of the single stage furnace, using both underfeed and spreader firing, have been operated successfully.

Another wood burning installation of much interest to the meeting was described in a paper on the industrial power plant of Weyerhauser Timber Co. of Springfield, Oregon by Conant Dodge, Assistant Chief Engineer of the company, and C. W. E. Clark of United Engineers & Constructors, Inc. The new plant is laid out to take all possible advantage of outdoor construction. The power plant is designed primarily for utilization of hogged fuel and steam conditions of 570 psi, 675 F at the superheater outlet, were considered logical for the conditions that will probably exist in the mill throughout its useful life. The plant was designed for present electric power load of 12,000 kw and for process steam loads of 95,000 lb per hr at 150 psig and 100,000 lb per hr at 40 psig.

History and performance of Pacific Gas & Electric Company's oil refinery steam electric generating station was reviewed by V. F. Estcourt, Engineer of Steam Operation, Pacific Gas and Electric Co.

AYE, LAD! THE SCOTS WILL HAE MORE POWER-R-R

HIGHLAND POWER SCHEME, a 35-mm film strip which describes the vast hydro-electric project under construction in the Scottish Highlands, is now available from British Information Services, 30 Rockefeller Plaza, N. Y.

Electricity is bringing new prosperity to the Highlands. Scotland's lakes and rivers, with a potential supply of 6,724,000,000 kilowatt hours a year, are being harnessed to create new economic opportunities for the Highland people. The filmstrip describes in detail the huge construction job and shows power plants already completed under the plan.

Consisting of 36 frames, *Highland Power Scheme*, with study guide, is available for sale at $1.00.

JOHN VAN BRUNT HONORED

JOHN VAN BRUNT, vice president of Combustion Engineering Company for more than a quarter of a century, and since January 1, 1949, engineering consultant for Combustion Engineering—Superheater, Inc., was honored on June 11 with the degree of Doctor of Engineering by Stevens Institute of Technology at its 1949 commencement exercises.

A graduate of Stevens with the class of 1897, Mr. Van Brunt has devoted his entire career to the power plant field. He has been responsible for the design of many of the largest and most efficient steam generating units now in operation.

COMING EVENTS

ISA—The Fourth National Instrument Exhibit to be held at the St. Louis Municipal Auditorium, St. Louis, Sept. 12-16.

NACE—A meeting of the South Central Section, National Association of Corrosion Engineers, will be held at the Adolphus Hotel, Dallas, Texas, October 3 and 4.

ASTM—The First National Meeting of the American Society for Testing Materials to be held on the West Coast will be held at the Fairmount Hotel, San Francisco, October 10-14.

ASCE—1949 Meeting of the American Society of Civil Engineers, Summer Convention, Mexico City, July 13-15; Fall Meeting, Washington, D. C., November 2-4.

Midwest Power Show—The 9th Midwest Engineering and Power Exposition will be held at Navy Pier, Chicago, November 11-16.

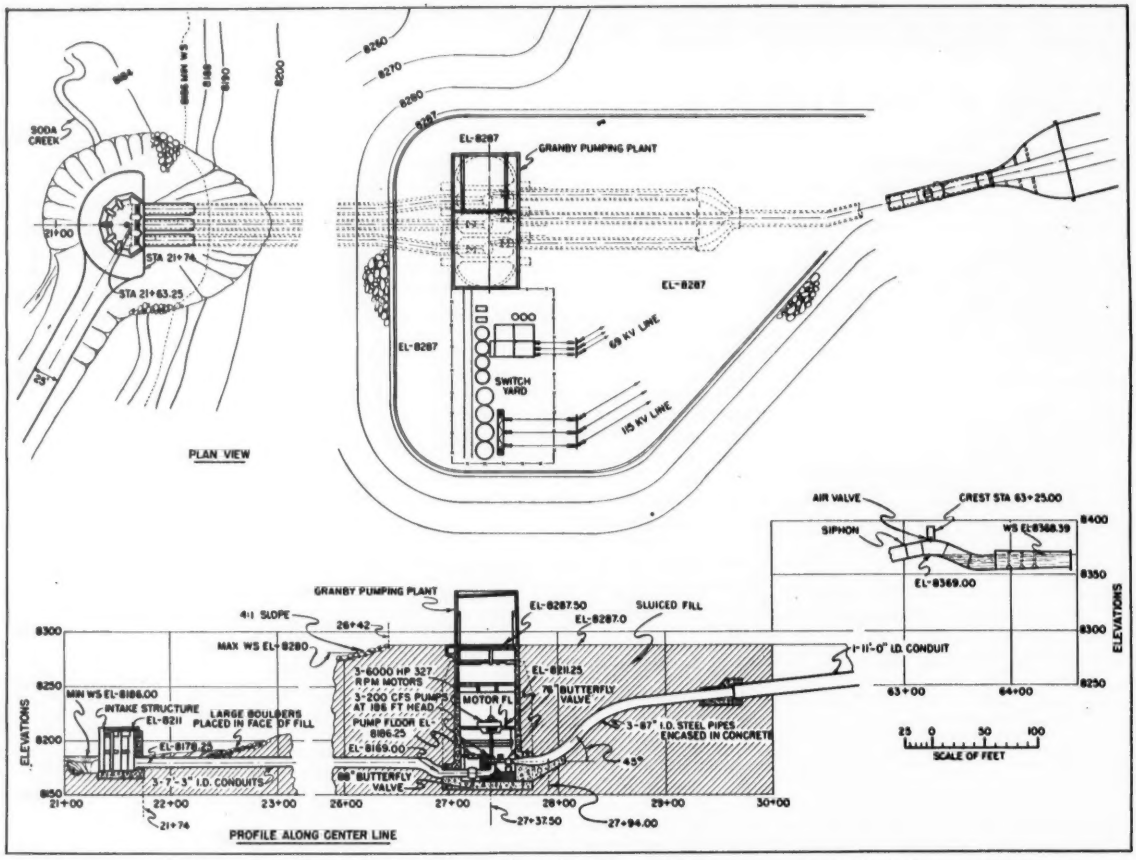


Fig. 1. General plan and profile of Granby Pumping Plant in Colorado-Big Thompson project, U. S. Bureau of Reclamation

New and Unusual Pumping Problems in Design and Operation of Granby

By **ELIOT B. MOSES,** Engineer, Bureau of Reclamation

GRANBY PUMPING PLANT, now under construction for the Bureau of Reclamation, is located near Granby Reservoir, 8 miles north of Granby, Colorado on the western slope of the Rocky Mountains. Water from the upper Colorado River and its tributaries will be stored in the reservoir during periods of high run-off. From the reservoir the plant will pump water up to Shadow Mountain and Grand Lakes; from there it flows by gravity through the 13-mile long Alva B. Adams tunnel under the Continental Divide to the eastern slope, where it will be used for both irrigation and power purposes.

The water level in Granby Reservoir will vary 94 ft. from a maximum elevation of 8280 ft to a minimum elevation of 8186 ft. The pumping equipment, Fig. 1, comprises three vertical shaft centrifugal single-stage pumps, each with a capacity of 200 cu ft per sec at the maximum pumping head of 186 ft. Each is driven directly through a flange coupling by a 6000-hp, 327-rpm, 6600-v, 3-phase, 60-cycle synchronous motor. The 87-in. diameter concrete suction line to each pump is 570 ft long and runs from a concrete intake structure located at a low point in the reservoir.

Determination of Pump Setting

Due to the 94-ft range of inlet head, the long suction line and the low barometric pressure at the 8180-ft altitude, it was necessary to set the pumps well below minimum reservoir level so as to insure freedom from cavitation throughout the wide range of pumping head.

From cavitation tests on a model of a similar type of pump a minimum value of the cavitation factor $\sigma = 0.112$ for Granby was established. Then, using prototype or actual full-

Table I. Calculation for Granby pump submergence to prevent cavitation

Maximum static head	185.00 ft
Total suction—velocity head (for 87-in inlet & disch. lines)	4.00 ft
Total pumping head	189.00 ft
$\sigma H = 0.112 \times 189$ ft	21.16 ft
Vapor pressure of water Hvp at 70 F	0.84 ft
	22.00 ft
Less barometric head Ha at El. 8150 ft	—25.04 ft
Net suction head	— 3.04 ft
Velocity head at eye of impeller, at 200 cfs	4.20 ft
Total losses, trashrack to eye, at 200 cfs	1.40 ft
Min. static head above crown of impeller req'd	2.56 ft
Height of crown above C. L. of pump	0.58 ft
Minimum submergence req'd	3.14 ft

Based on a paper entitled, Hydraulic Problems in Connection with the Design of the Granby Pumping Plant, presented by the author at the Annual Meeting of the ASME, 1947.

Granby Pumping Plant being built for Colorado-Big Thompson project by U. S. Bureau of Reclamation . . . Delivers 600 cfs of water for irrigation and power . . . 94 ft variation in suction head . . . Three pumps, 200 cfs each, driven by 6000-hp synchronous motors, draw water through 570-ft, 87-in suction line, discharge it through 11-ft line 3500 ft long . . . Pumps far below ground level; submergence to prevent cavitation . . . How pumps are started by increasing motor torque in steps while head, discharge, speed and pump torque are all variable . . . Operation of pumps . . . Discharge valve and siphon . . . How surge tank need was eliminated . . . Water depressed below impeller for reduced voltage start . . . Starting and stopping pumps without pipe line surges, electrical disturbances

size pump values, the submergence was calculated as in Table I.

Since the centerline of pump is at El. 8180 ft and the minimum reservoir level is 8186 ft the actual submergence of 6 ft, as compared with the required minimum of 3.14, should be ample to ensure freedom from cavitation at the lowest level of Granby Reservoir.

The three Granby pumps discharge through 87-in. steel pipes branching into a single 11-ft inside diameter concrete conduit that conducts the water up to the level of Shadow Mountain and Grand Lakes, the total length of discharge pipe being 3500 ft. Originally it was planned to omit the shut-off valves on pump discharge; and studies were made to determine the necessary starting characteristics for the motor and its control while the pump was accelerating and building up the head of water in the long pipe line.

Methods of Starting Pumps

For solving this problem, wherein the head, discharge, power, speed, and efficiency are all variables at any instant of the starting period, use is made of a pump characteristic diagram of a similar pump, Fig. 2, which shows these variables by means of a series of curves based on percentages of the corresponding values at the 100-per cent or rated operating point. From this diagram, the corresponding values could be calculated for any assumed condition during the accelerating period. In this example, the motor torque is increased in uniform steps of 10 per cent up to a maximum of 110 per cent of normal to provide sufficient margin for prompt synchronization. It was assumed that the torque required to breakaway the unit from the static friction of rest would be 25 per cent of full torque load, so the motor would not start to move until the 30 per cent torque step had been applied.

A reservoir curve for the discharge pipe was then plotted showing capacity in cubic feet vs. elevation. The method, briefly, consists of applying an increment of torque during a short interval of time, accelerating the unit to a new speed and from Fig. 2 determining the corresponding percentages of head, discharge and torque. Total friction and vindage losses vs cent speed were plotted; these losses plus torque required for pumping gives the total required torque at that instant. The difference between the applied torque as determined by the control and the total required torque is that remaining for accelerating the unit, Fig. 3. These curves show how the unit will continue to accelerate as long as the applied motor torque is greater than the pump plus friction and windage torque at which time a new increment of motor torque is applied.

Operation of Pumps at Granby

Ordinarily, the Granby Pumping Plant will be connected to the power system on the eastern slope of the Rockies through a 115-kv transmission line. This line extends over much mountainous country crossing the Continental Divide by way of 11,700-ft Buchanan Pass, and as outages due to storms, slides, and so on are likely to occur, the pumping plant has been designed so that the pumps can be started on the limited power supply from the Green Mountain Plant, located on the western slope and connected through a 69-kv line, 45 miles long.

To keep the line disturbance to a minimum when starting the pumps, particularly when starting from the comparatively small capacity 24,000-kva Green Mountain Plant, various studies were made on a small pump of quite similar characteristics, using shut-off valves in both suction and discharge lines with admission of compressed air to casing for depressing the water level below impeller, the pressure being measured by special pressure cells operating a recording oscillograph.

Various tests were conducted (1) with discharge valve open and throttling by intake valve, both with and without aeration or admitting air to the suction side, and (2) with intake open and throttling by the discharge valve, air being admitted to suction side of pump. In (1), severe surges and cavitation occurred during both the starting and stopping periods, which proved this method unsuitable for the large pumps. The method of operation adopted is based on (2) and is illustrated in Fig. 4A and B with intake valve open and throttling by the discharge valve.

In the starting cycle, Fig. 4A, the

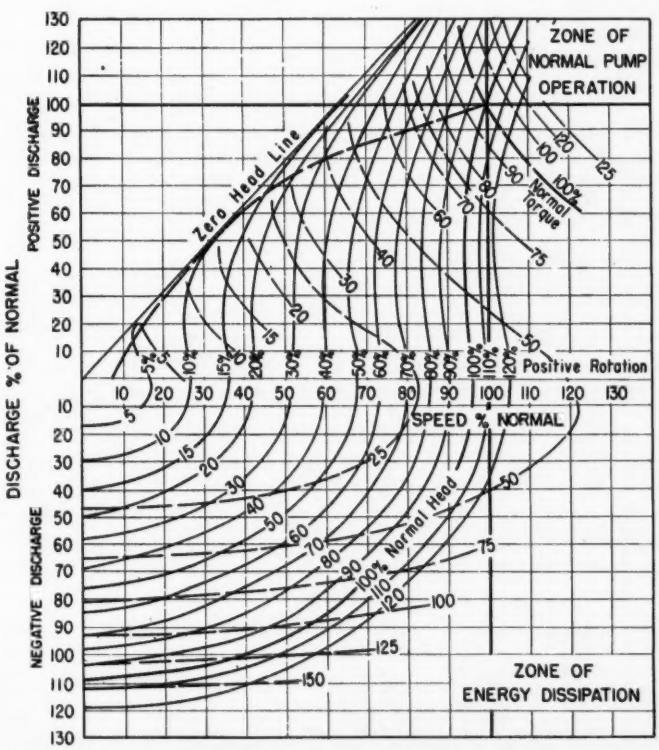
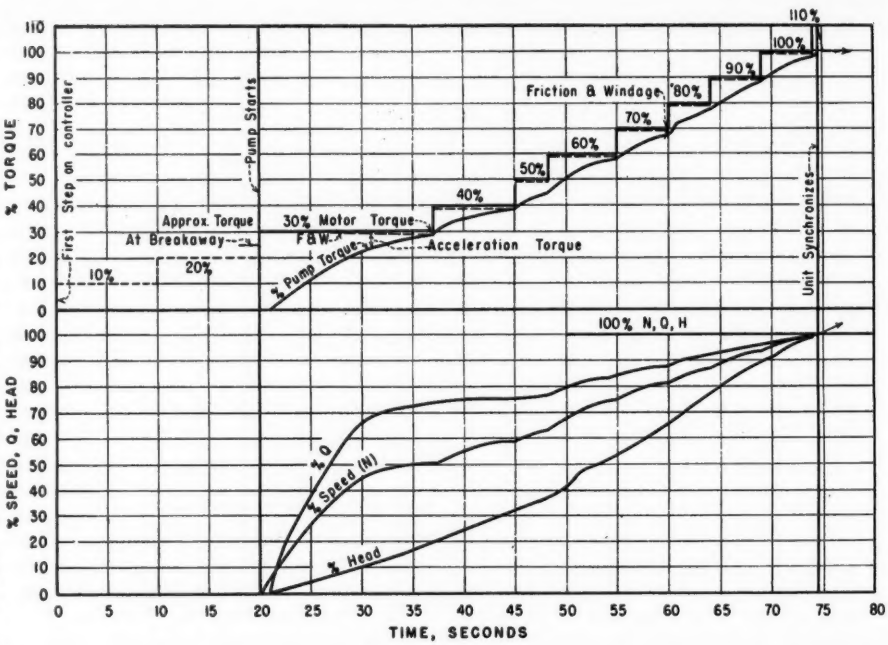


Fig. 2. Double volute pump characteristic diagram

Fig. 3. Computed values of head, torque, discharge and speed vs time for one of the Granby 200-cfs pumping units



pump is started with the discharge valve closed and the water level depressed below bottom of impeller by compressed air. The air is then exhausted and when case is nearly free of air, the pump suddenly primes and shut off head conditions are reached. As the discharge valve is opened, flow is established and the head drops to normal.

In the stopping cycle, Fig. 4B, the discharge valve, as it nears closure, builds up the head to shut-off condition; then, as compressed air is admitted to suction tube, the head drops and when the level has reached the bottom of the impeller and the net head approaches zero, the motor circuit is opened. The oscillograph records show no severe surges, the heads gradually building up or falling and are always positive. For this reason this method will be used for the large pumps for it will reduce power surges and the likelihood of cavitation.

Control of Pumping Unit

The pumping unit may be controlled from two stations, one at ground level, El. 8287.5, the other on the pump floor at El. 8186.25 ft. The starting procedure is divided into two parts:—

(1) Starting auxiliary equipment, consisting of guide and thrust bearing oil pumps; admitting water to motor cooler and thrust bearing cooler, and to pump gland seal and guide bearing cooler.

(2) Starting motor through automatic control switch gear which includes field application equipment in cubicles adjacent to the motors.

For normal or full-voltage starting after the motor is synchronized, a control switch is operated which opens the butterfly discharge valve while simultaneously closing the bypass valve.

Table II. Estimated torques for one Granby pump unit, based on 6000-hp maximum motor output at 327 rpm

	Torque ft-lb	Kva	Notes
Full load, normal pumping	96,400	4,920	(0.95 Power Factor)
Shut off, impeller submerged	49,000	2,410	(0.95 Power Factor)
Breakaway, thrust bearing oil immersed	11,580	29,400	Inrush power —full voltage
Breakaway, thrust bearing oil immersed	11,580	4,000	Inrush power 38.6% voltage
Breakaway, thrust bearing suported on oil film	4,800	29,400	Inrush power —full voltage
Breakaway, thrust bearing supported on oil film	4,800	4,000	Inrush power 38.6% voltage
Unit Motoring at synchronous speed, impeller unwatered	1,230	57	

For reduced voltage starting, the same procedure is followed except that in addition to the operation of the above auxiliaries, cooling water is admitted to the seal rings, the air vent to pump casing is closed and air admitted to depress water level below impeller, the level being controlled by a float valve.

After the motor has been synchronized at reduced voltage, open circuit transition to full voltage takes place. When the motor is on the line the casing air vent is opened and pump allowed to fill, when normal pumping is established upon opening butterfly valve and closing bypass valve.

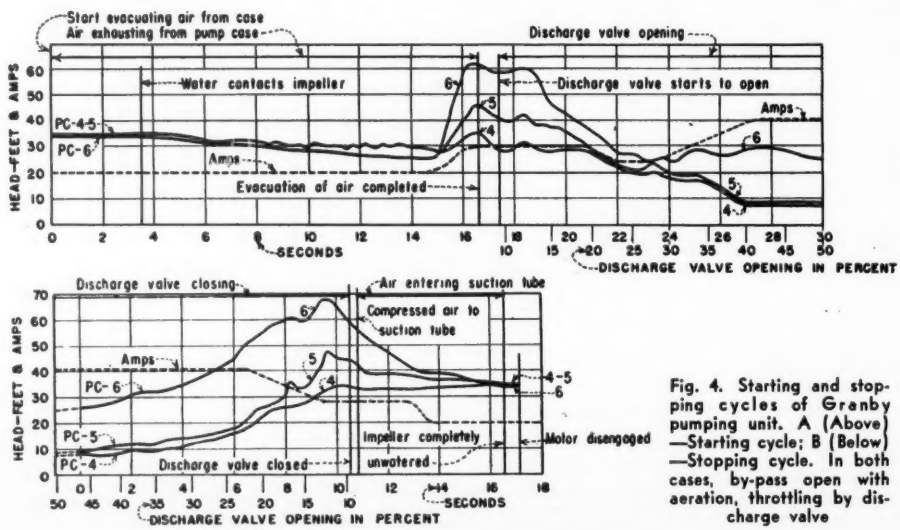
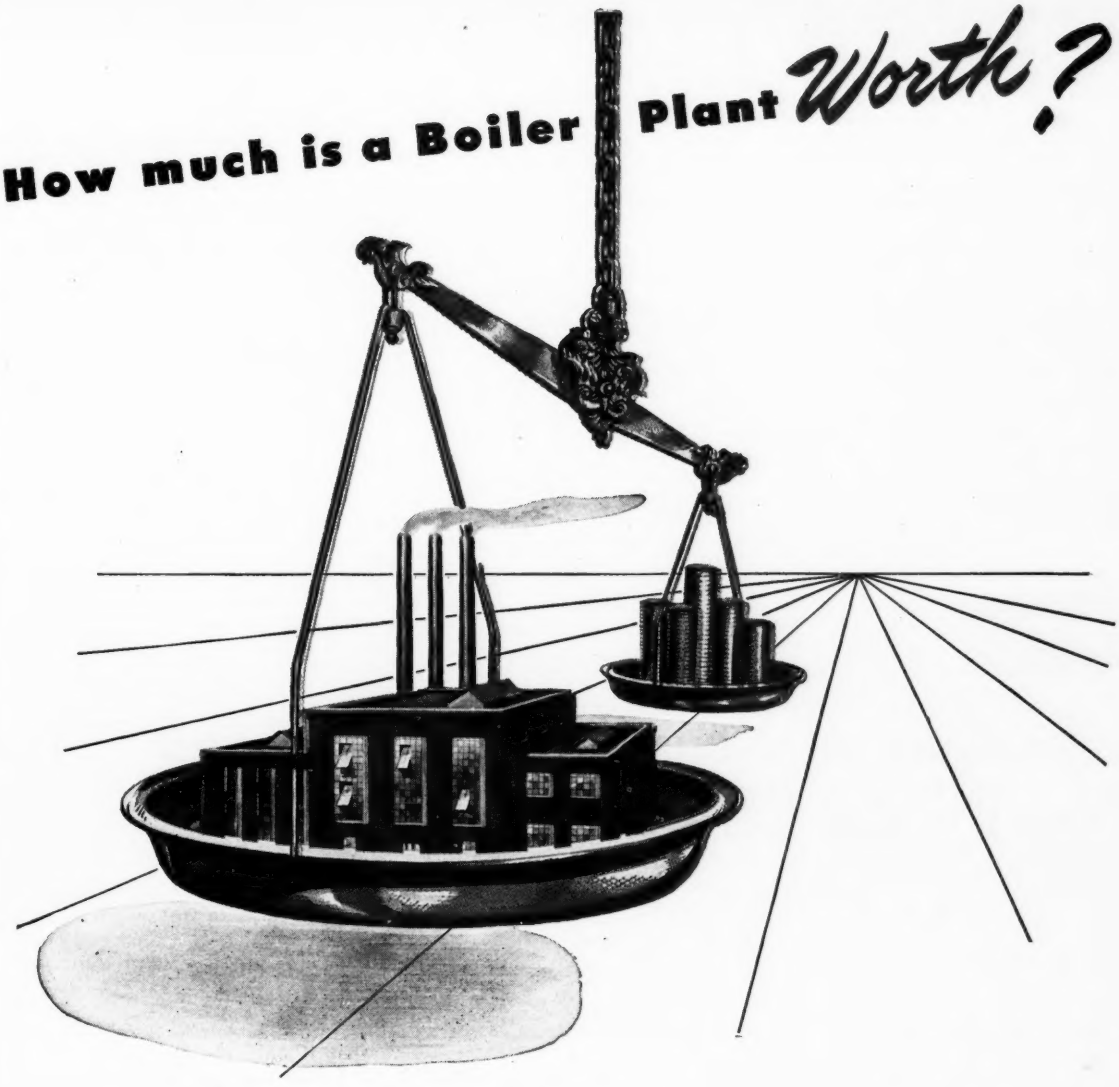


Fig. 4. Starting and stopping cycles of Granby pumping unit. A (Above)—Starting cycle; B (Below)—Stopping cycle. In both cases, by-pass open with aeration, throttling by discharge valve

Discharge Valves

Original design of the plant included a surge tank connected to the discharge conduit and located 300 ft from the pumps. Due to a larger WR^2 for the motor, a lower-

How much is a Boiler Plant *Worth?*



A boiler plant may *cost* up to any figure you wish to name. But a boiler plant's *worth* depends entirely upon how efficiently it operates. For instance, how many or *how few* shut-downs you have may depend entirely on the effectiveness of your water conditioning service.

Correct water conditioning is a matter of careful and scientific control.

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ing of the grade of the discharge line near the pumping plant and a reduction in rate of closure of the 76-in. discharge butterfly valve, it has been found possible to omit the surge tank, making substantial saving in steel tank and expensive concrete foundation. Water-hammer calculations show, under the most severe conditions of emergency closure, that the minimum momentary drop in pressure after power failure is, at this altitude, 11 ft above absolute zero; consequently a pressure rise of the instantaneous type, due to separation of the water column will not occur.

The 76-in. butterfly discharge valves are operated by hydraulic servomotors that receive oil from a central pressure system. Water-hammer studies are based on a closing cycle of the first 75 per cent of angular movement in 12 sec and the final 25 per cent in 30 sec or 42 sec for full 90-deg movement. The opening cycle is made the exact reverse of this to simplify the control apparatus. These opening and closing cycles apply to all conditions of operation, both normal and emergency. The control mechanism consists of a 4-way piston valve with solenoid operated pilot valve, which permits manual operation from the control station.

Governed Like a Hydraulic Turbine

The design of the butterfly valve control mechanism follows closely that of a conventional governor for hydraulic turbines. This is particularly advantageous at Granby since some of the pumping will be done at short intervals each day to utilize off peak secondary power and the starting and stopping sequences should be as nearly automatic as good design will permit.

Discharge Siphon

A concrete siphon is located at the top of the discharge conduit to prevent back flow from the canal as shown in Fig. 1. To insure rapid breaking of the water column when the pump stops, an automatic air vent at the top of the siphon is provided, controlled so as to insure prompt opening under emergency conditions if power fails. A float-controlled vacuum pump prevents the formation of an air pocket at top of the siphon and insures the siphon operating efficiently at all times.

The use of the automatically closing butterfly discharge valve, and siphon with automatically-operated air vent will prevent the emptying of the long discharge conduit when power to pump is cut off and will eliminate the resulting high reverse speed rotation and the necessity of refilling the long conduit after each shut down.

SAFETY

Take Care of Your Safety Valves and They'll Take Care of You

Boiler's most indispensable safety device . . . Every power engineer should know his safety valves thoroughly . . . Routine tests to discover if valve is stuck or not operating right . . Causes of valve sticking . . . Right and wrong way to install safety valves . . . Precautions in checking with the pressure gage

By C. C. CUSTER

THE SAFETY VALVE is the most important and indispensable of the various safety devices with which a boiler or other pressure vessel is equipped. It is a special device for relieving pressures and for keeping them within certain bounds. If the safety valve is selected to meet the conditions, properly installed, satisfactorily maintained, and periodically tested, it can be relied on to function with greater certainty than any other limiting device known. The power engineer must become thoroughly informed on its design, operation, installation, and maintenance.

First, Master Code Requirements

First of all, the ASME Code requirements on safety valves should be mastered. A copy of this code should be in every engineer's library. Second, the engineer should study how variations in safety valve design affect the solution of different safety valve problems and should be able to select the type of valve that will best meet the conditions.

The old type of weight-and-lever safety valve is banned by law in most states and the pop safety valve is universally used.

The spring pop valve is superior to the old lever and weight valve in that the adjustment, when once made, cannot be easily tampered with. Moreover, the valve is inclined to remain tight under service because it employs the blow-back principle, whereby the valve opens suddenly and freely and, after blowing back about 4 per cent of the steam pressure carried, it seats suddenly and forcibly. This eliminates leakage at the seat, which, if prolonged, causes the surfaces to become grooved and leaky. Spring pop valves of good design often remain tight for a number of years, provided the service is not too severe. In fact the service is generally so good that the engineer often forgets all about the safety valve and often forgets or omits occasional testing. This ought to be done as a matter of power plant routine.

When there are several safety valves say, on a 200-psi boiler it is customary to set valve No. 1 at 200, No. 2 at 203, and No. 3 at 206 psi. Each valve should have a wire pull-off attached to the lifting lever so that if only the first valve blows, the engineer can pull off the other two valves to test them while the pressure is still within their blow-back range. If a safety valve does not get a work-out once in a while, it sometimes sticks fast on its seat, and its failure to operate may cause a serious hazard.

Chattering, Simmering, Hang-up

There are several reasons why safety valves sometimes stick. The feather or seat castings of safety valves must have close-fitting guides to center them properly, similar to check valves. Also, like check valves, they are liable through too snug a fit or the presence of corrosion or of foreign matter to stick either in the closed or open position. Working parts of safety valves should be made of non-corrosive steam metal or other suitable metals, but even these metals sometimes corrode under action of alkalis or acids in the boiler and many manufacturers are turning to the high-temperature alloys.

Salient symptoms of abnormal pop

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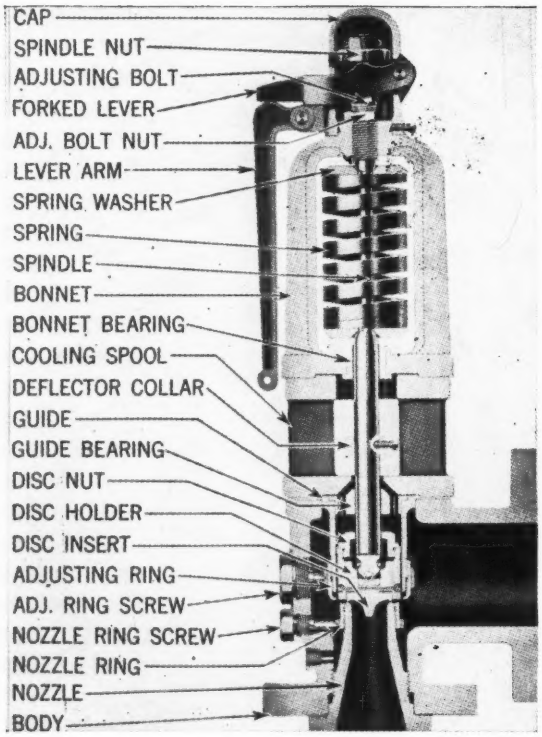


Fig. 1.—Left. Construction details of a standard safety valve of present-day design

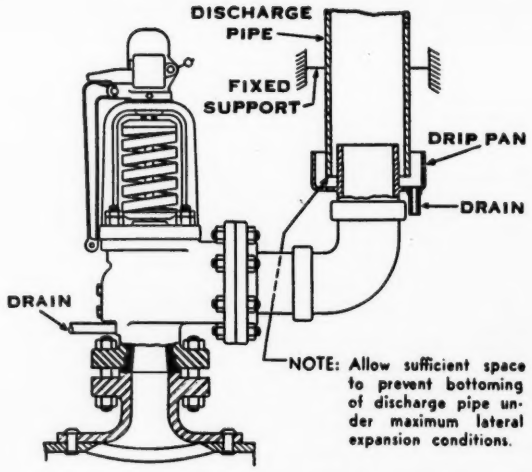


Fig. 2.—Above. This is the proper way to install a safety valve on a boiler drum

valve action are chattering, simmering, hang-up, and leaking.

Chattering is a metallic hammering sound that takes place immediately after popping or just before closing. The first indicates insufficient steam flow or excessive back pressure. The second indicates too small blow down, caused by adjusting ring being out of position. The purpose of the adjusting ring is to increase the area on which the steam impinges so that when the flow has once started it will continue till enough blow-down is secured so that the valve will seat forcibly. Chatter, if not stopped, may ruin the seat.

Simmering is a light chattering noise or hissing sound that tells you the valve is getting ready to pop and many engineers or boiler tenders will run and close down on the draft partly, so as to stop the boiler from popping off. A two or three-pound simmer is allowable and only indicates a slight irregularity in the seats. Greater simmer may indicate incorrect blow-down control and that the adjusting ring is not in the best position.

In regard to what is termed hang-up, after a valve has popped and blown down an appreciable amount but will not close tightly, it is an indication of mechanical interference or improper blow-down adjustment. If increase of blow-down adjustment does not correct the trouble, the valve should be taken apart, and one may expect to find damaged seats or defective parts.

Correct Valve Sizing and Installation

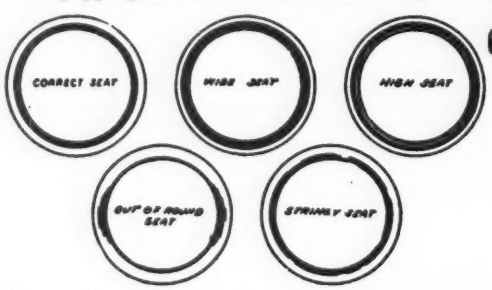
Figure 3 shows what a correct seat ought to look like, also shows seat worn too wide, or out of round, and so on. If the engineer has not the equipment and experience necessary for grinding in a valve, it is better practice to have a spare valve in stock so that the defective valve may be replaced and sent back to the manufacturer for reconditioning.

It should be noted that valves are not made in larger than 4½ in. size. If the size of boiler requires a valve as large as 4½ in., the writer would rather use two 3-in. valves to get the same capacity. Experience shows that the valves of larger diameters are harder to keep tight in service.

It is a mistake to hang too much weight of pipe or fittings onto a safety valve, for that may throw strains on the valve body. Figure 2 shows how a safety valve should be mounted close to the boiler; the fittings not under pressure should have open drains so no entrained water will accumulate. Figure 4 shows a proper Y-fitting to use, in case two valves are to be installed on one outlet at boiler. The area of the two branches together should equal the area of the boiler outlet.

How NOT to Install Safety Valve

Figure 6 illustrates wrong conditions. Figure 6 is wrong because the Code says a valve as large as 3½ in. shall have a standard flange connection instead of a screw connection. In Fig. 6 is another violation of the Code, which states that valves



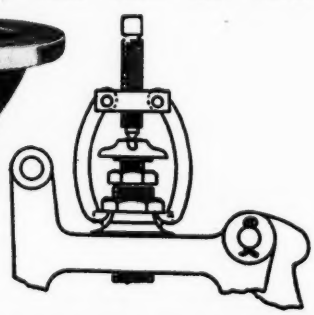
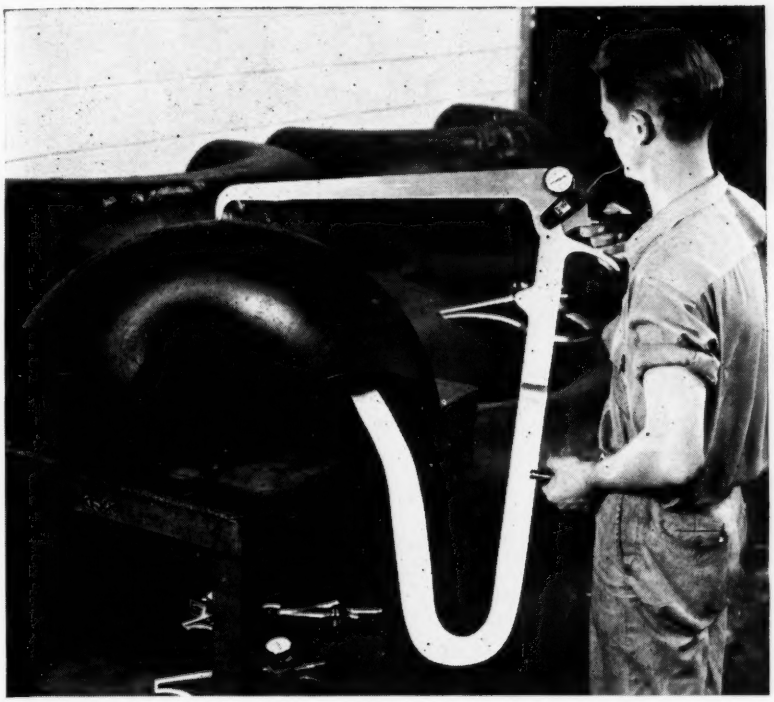


Fig. 3.—Left. Diagram of correct and faulty safety valve seats. Fig. 4.—Center. Two safety valves installed on this approved Y-fitting, in which area of boiler outlet equals sum of areas of two branches. Fig. 5.—Right. Gag for holding safety valve while adjusting it



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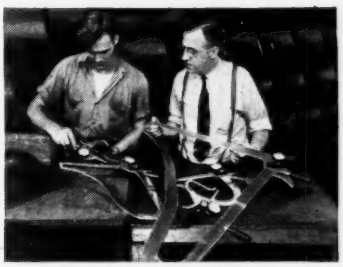

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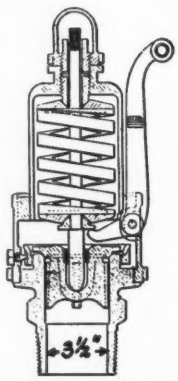


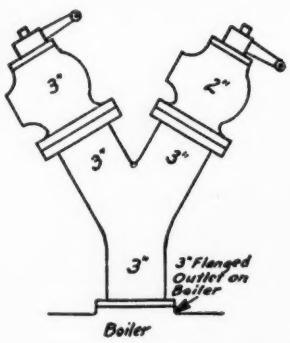


Fig. 6.—WRONG—On a 3½ in. valve, flanged inlet connection is required by the Code. WRONG Valves at right should be vertical, also sum of branch areas not equal to area of boiler outlet

should be mounted in a vertical position and that the sum of the areas of the branches should be the same as that of the boiler outlet.

One method employed to check the setting of a safety valve for accuracy is to check it against the steam pressure reading. The natural tendency of steam gages is to weaken in use and therefore to indicate higher than the real pressures. A maxim to be followed in setting a safety valve is to first see that the steam gage is calibrated correctly. In many states, the law requires a special outlet on the line to the steam gage for attaching inspector's test gage to verify the correctness of the gage in use. This is the procedure insisted on by the ASME Code.

Editor's Note:—Many questions of safety valve setting, blow-down, relieving capacity, and the like are discussed in detail in an article on Safety Valves for Stationary Power Boilers, by John R. Kruse, *Combustion*, March, 1948. See also discussion and comments on Question No. 435, Why did Safety Valve Blow Incorrectly? February, March, April issues.

A subsequent article in POWER GENERATION will discuss the relations of blow-down and setting pressures and the use of the power control valve in installations where extremely low blow-down is necessary.

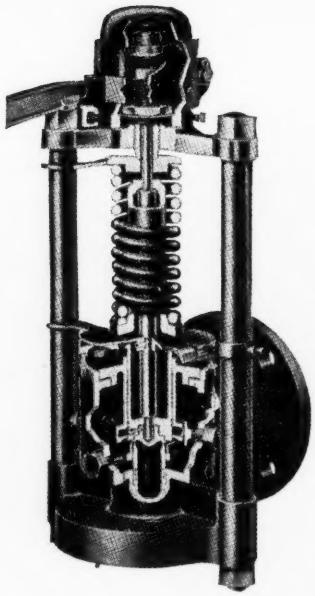
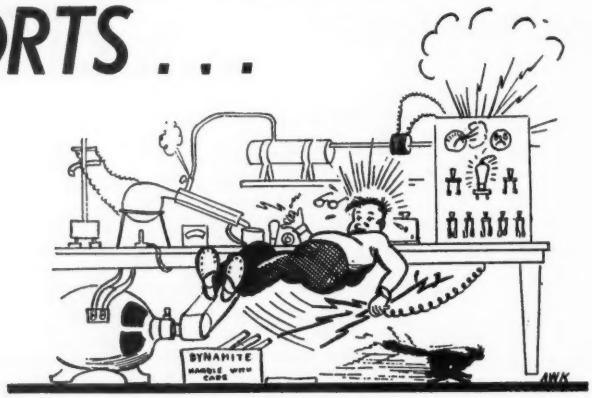


Fig. 7. Another type of modern safety valve designed for uniform popping pressure, with passages designed for smooth flow, low accumulation, seats and disks of proper metals to resist corrosion, seat square, and prevent sticking. Designed for blow-down adjustable from 8% down to 1%. For steam up to 3000 psi, 1000 F

SHORTS . . .



Moisture has long been one of the greatest sources of trouble in electrical equipment and installations. Paradoxically, a new electrical wire has been developed with insulation that improves when soaked in water. The insulation also has improved tensile strength and elongation.

* * *

The complexity of a new turbine type aircraft engine is illustrated by the fact that the latest one required 7,600 different tools to produce its more than 900 parts. This engine develops a static thrust of 5000 pounds, the highest of any American engine.

* * *

How insignificant events may shape human destiny is illustrated by the common "lead" pencil. The modern pencil dates back to 1564 when a windstorm blew down a tree which uncovered a graphite mine in Cumberland, England. Now, Americans alone, use 1,250,000,000 pencils a year. A nice time to remember this figure is the next time you receive a phone call and try to find the inevitably lost pencil.

* * *

The most popular of the 29 stainless steel alloys, known as 18-8, contains about 18 per cent chromium and 8 per cent nickel.

* * *

Research metallurgists have succeeded in producing thin single crystals of metals only ten mils thick but as large as a half-inch square. These are used in X-ray and diffraction studies on the effects of chemical reactions.

* * *

The jet engine may find use on railroads—but not for propulsion. A large western railroad is experimenting with jet brakes for use on fast diesel trains. On these high speed trains, friction on the brake shoe and between the wheel and rail is inadequate for quick stops.

* * *

Most leathers become hard and lose strength after becoming wet. Now, however, a new synthetic tanning agent produces leathers which are soft and strong and can be washed or dry cleaned repeatedly. All that is necessary to restore the leather to its original softness is gentle flexing and stretching.

* * *

In a continuous strip rolling mill, the flat rolled strip is traveling faster at the finished end than at the beginning even though the steel is one continuous piece. The explanation is that as the steel is rolled thinner at each roll, the metal is elongated and the next set of rolls must turn faster to take up the slack. The speed may increase from a few hundred feet per minute at the beginning to nearly a mile a minute at the end.

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Series 450 FIG. 13

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DCP TRY COCK

—Bronze Construction— with Iron Weight lever

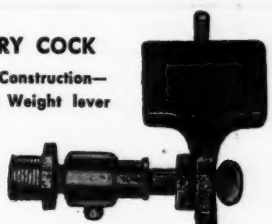

Fig. 15

Working pressures up to 250 lbs. This Double Chain Pull Try Cock insures a tight shut off. Sizes: ½" or ¾".

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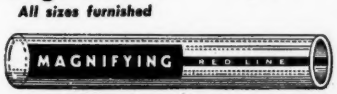
LIP MOLD Fig. 21

STANDARD Fig. 22



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By **SERGIO MARTINEZ, JR.**
Plant Engineer, Compania Textilera Ariguanabo, S.A.

Fig. 1. General view of the power plant showing the 100-ft concrete chimney with breeching

TEXTILERA ARIGUANABO, S.A., is a large textile mill located in Cuba, 20 miles east of Havana. It has been in operation since 1932 and two years ago it was decided to double its size with the corresponding need of larger quantities of power and steam.

The existing power plant consisted of a single Foster Wheeler Type SA boiler capable of delivering 55,000 lb per hr at a pressure of 400 lb and a temperature of 700 F, and a single 3500 kw General Electric turbo-generator. This plant was installed in 1940 and, on account of the war, it was impossible to obtain the second boiler and turbine originally planned, with the result that for six years the plant worked at full capacity 24 hours a day, six days a week, without any spare equipment for emergencies. If to this situation is added the fact that oil was very scarce and asphalt with 5 per cent ash had to be burned in a furnace designed only for fuel oil, it will be realized what a job it was to keep this plant operating during the war.

The load calculations in 1939 showed a future demand of 2800 kw of electrical load and 15,000 lb per hr of extracted steam for process. With these values to work on the 1940 plant was to have two 3500 kw turbo-generators and two 55,000 lb per hr boilers.

During the war, the load started increasing and a future load estimate made in 1944 showed that in the future we could expect to have 4500 kw electrical load with 30,000 lb of steam demand for process.

With these figures as a basis, it was decided to build a new power plant in a separate building and to install in it two new 5000 kw turbo-generators and to sell the old 3500 kw unit.

Assuming that the electric load went as high as 5000 kw and that the steam demand as high as 40,000 lb per hr the boilers would have to supply about 80,000 lb per hr according to the turbine characteristics. This figure does not include steam used for feedwater heating. Since we had on hand one 55,000 lb per hr boiler, it was decided to buy two duplicate units and run them at about 83 per cent rating. This means a slightly higher initial investment, but gives an arrangement with all three boilers alike and one which is more flexible to handle any sudden demand.

The new boilers are oil-fired like the previous one, but they were mounted five feet higher in order to obtain more furnace volume and to facilitate removal of the ashes should we ever have to burn asphalt again. The steam pressure was kept the same, but it was decided to increase the temperature to 825 F, by adding more superheater surface to the boilers in order to improve the overall efficiency.

The new power plant was designed to be as nearly as automatic as possible without going into large expenditures. This is necessary on account of the difficulties in obtaining skilled labor. The turbo-generators have not only voltage regulators and a speed governor, but

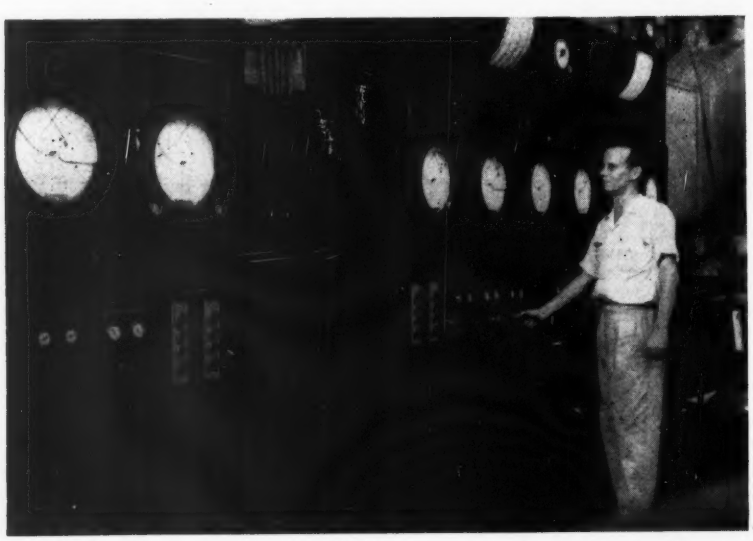

Fig. 2. Boiler control panels with Plant Foreman, J. R. Brown at the controls

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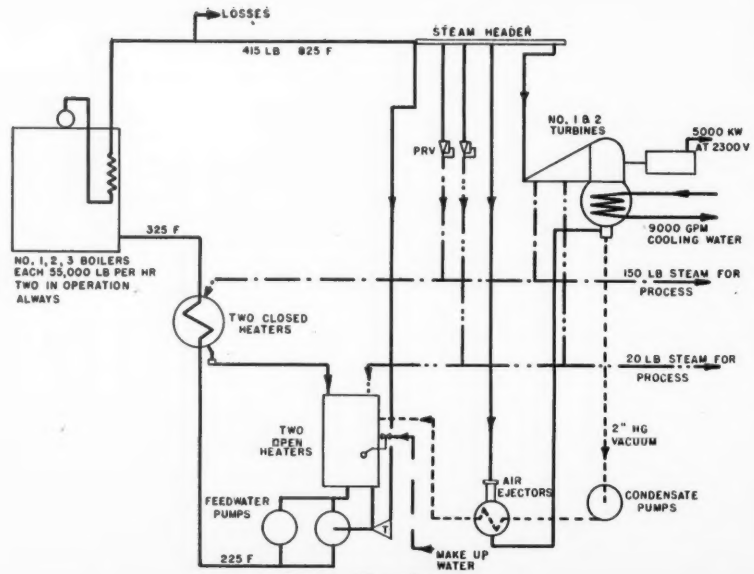

Fig. 3. Flow diagram

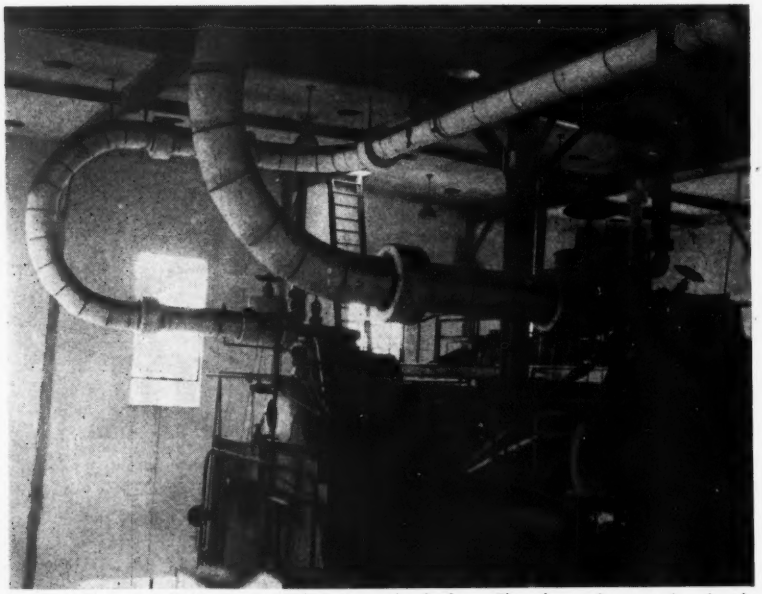

Fig. 4. Close-up of the steam outlets from the boilers. This shows the 180 deg bends for expansion and for supply of steam to soot blower lines

also have automatic extraction pressure control, all kinds of electrical relays and automatic synchronizing equipment. Two condensate pumps are provided for each condenser as well as twin air ejectors and besides the direct-connected exciter in each machine, a separate dual-drive exciter is provided for emergencies.

Each turbine is provided with six recording Bailey meters in order to have daily records of all values of status pressures, temperatures, water temperatures, vacuum, etc.

Each boiler is provided with Bailey Automatic Combustion equipment and Automatic Water Level control. Besides these controls, six more meters record all values of gas and air temperatures, oil pressures and temperatures, etc.

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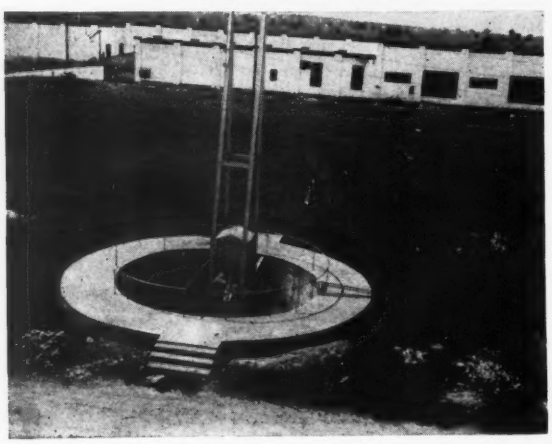
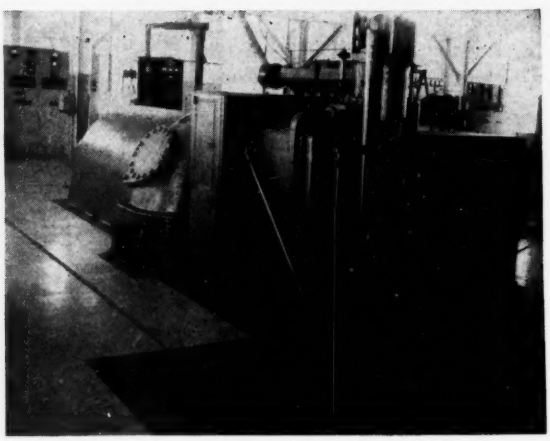
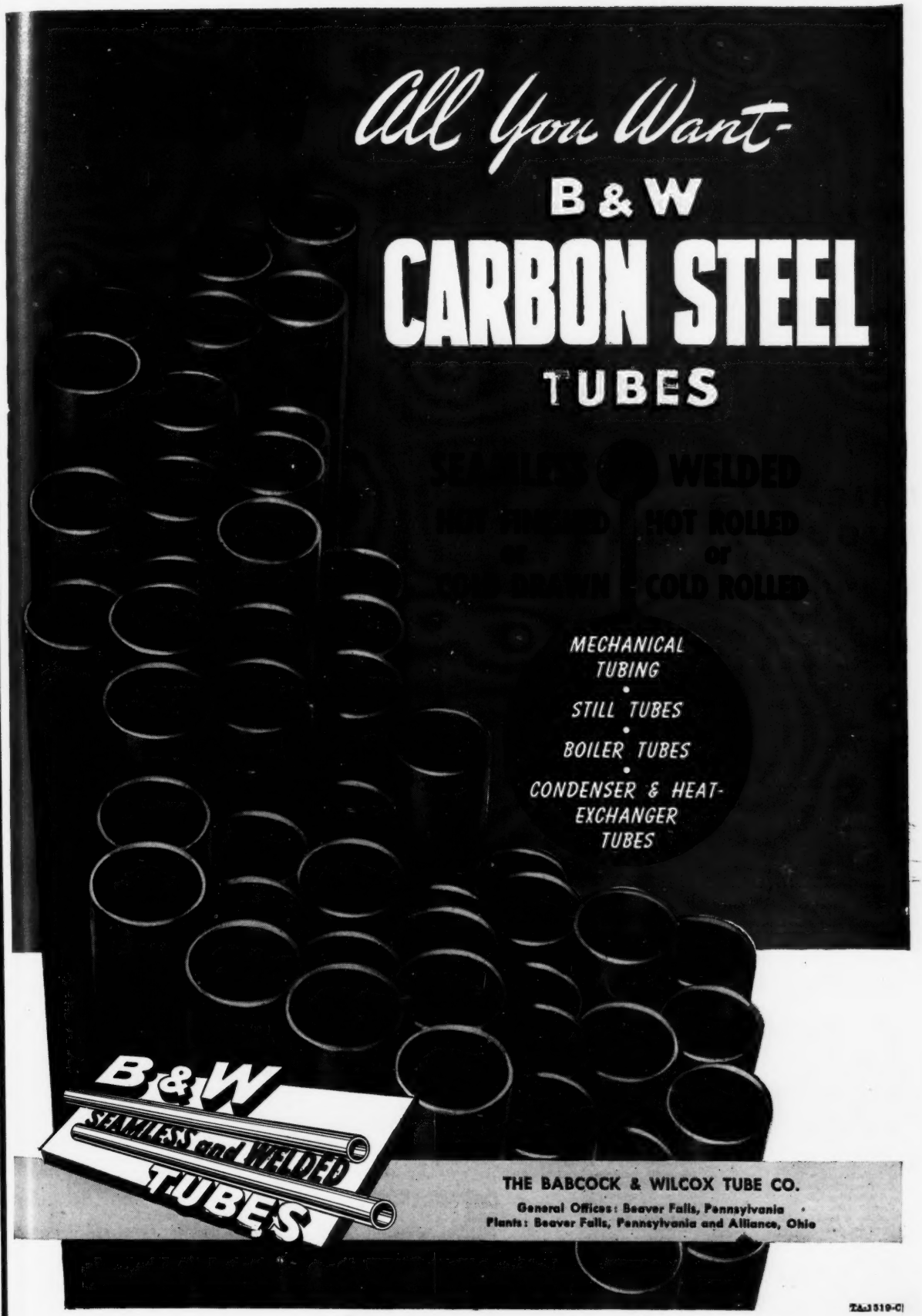
Fig. 5. Below Left: View of No. 1 well for circulating cooling water. The well is 24 ft inside diameter, 23 ft deep, and supplies 9000 gpm for condenser cooling air cooler and oil cooler. This view shows the vertical pump at the center supported by two 18-in beams, the protective housing for the pump motor and the permanent structure in top for raising the pump

Fig. 6. Below Right: Turbine No. 1. At the front can be seen the automatic extraction pressure control. At the far right is seen part of the main switchboard. This is one of the two 5000 kw, 2300-v generators installed in this plant. The condensers are supplied with circulating water taken from deep wells, as shown in Fig 5



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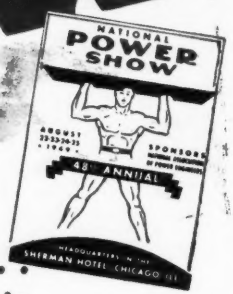

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rangement comes from the fact that the two small ones were available from the existing plant.

The switchgear is of the metal clad type with separate bus for each machine and a synchronizing bus for interconnection through proper size reactors. Automatic synchronizing equipment is provided as well as all kinds of relays for protection.

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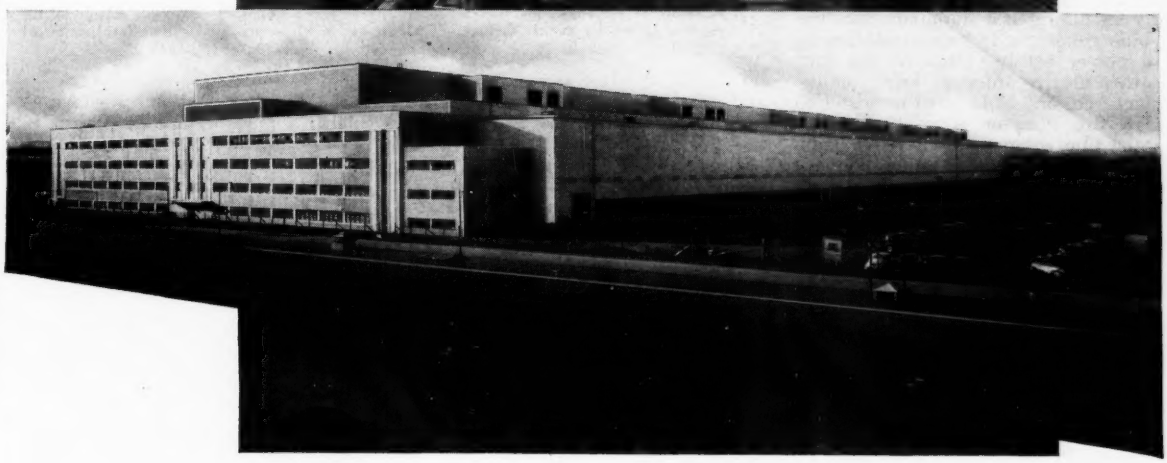
Interior of General Electric Turbine Building, Heavy Equipment Area.



To meet the growing power demands of industry, General Electric Company retained Stone & Webster Engineering Corporation to design and construct at Schenectady, New York, its new turbine manufacturing plant.

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Where the Gas Turbine for Power Generation Stands in 1949—a Progress Report

DESPITE the pessimists and the technical obstacles, the gas turbine for power generation alone is here in commercial form in 1949. True, the proponents of this, our fourth prime mover, are now bending over backward to prevent the public from expecting it to lead to a power revolution. It will require many more years of testing and operation before the true place of the gas turbine, and its proved performance, will be known—many years before it will generate any appreciable amount of our power.

Nevertheless, remembering the length of time it has taken for commercial development of many other power ideas, the gas turbine has made remarkable progress. Today, as this is written, a locomotive powered by a gas turbine is actually on the rails; a stationary gas turbine generator is being installed by a power utility company and four other ultility units are being manufactured, one at least to be installed late this summer; a gas turbine for pipe line compressor drive is being installed and another being planned; four locomotive and three marine gas turbine plants are under construction; and other plants are being designed and planned. Full technical details of design and construction have been presented by the equipment manufacturers in recent papers before AIEE, ASME, MPC and other societies, as listed at the end of this article. Here is the box score as of June 1949:

Fig. 1. View of Alco-GE gas turbine locomotives, rated capacity 4500 hp, designed for 79 mph max., fired by Bunker C fuel oil; 53 hp per ft of length, continuous tractive effort 68,500 lb at 20 mph. Announced to public June 16, 1949

1. Installation of 4800-hp gas turbine power plant in Alco-GE locomotive, now on rails for testing, with considerable test commercial hauling behind it, to be further tested commercially by Union Pacific Railroad this summer. See Figs. 1 and 4.
2. Installation now being made of 3500-kw GE stationary gas turbine generator unit at Arthur S. Huey Station, Oklahoma Gas & Electric Company (increases station capability by 7000 kw) Fig. 3.
3. Installation being made of 2000-hp Westinghouse gas turbine to drive centrifugal compressor or booster on gas pipe line of Mississippi River Fuel Corp. Initial operation to be with liquid fuel, later with fuel from the gas pipe line. Two other 2000-hp gas turbine power plants for a 4000-hp locomotive being built by West-

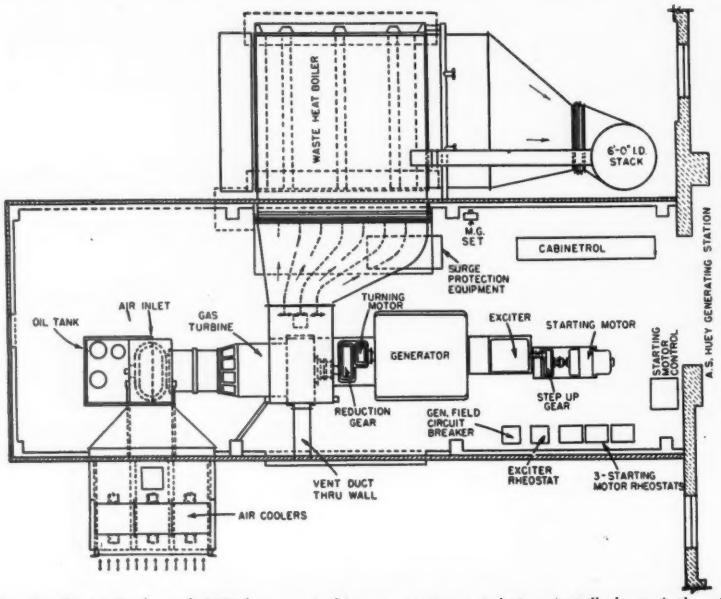

Fig. 2. General plan of 3500-kw gas turbine generator set being installed at Arthur S. Huey Generating Station, Oklahoma Gas & Electric Co. (Power Service & Engineering Co. drawing)

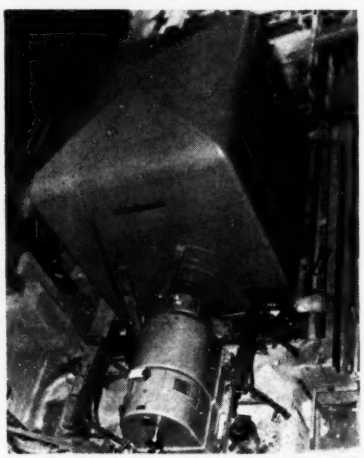

Fig. 3. Construction view, June 17, 1949, showing 3500-kw generator and exciter of GE gas turbine generator set under installation at Arthur S. Huey Generating Station, Oklahoma Gas & Electric Co. (Pioneer Service & Engineering Co., Consulting Engineers)

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inghouse. Also, collaborating with another manufacturer, gas turbine generator set, for locomotives taking fuel from free-piston compressors, will be built.

4. Three 2500-hp Elliott Co. gas turbine power plants under construction for marine propulsion, using rotary positive displacement (Lysholm) compressors; turbine inlet temperature 1400-F; also a 4100-hp locomotive gas turbine power plant using a centrifugal compressor, Fig. 6.
5. Construction going ahead on new design of GE 5000-kw gas turbine stationary power generating units, of which: 1 goes to Bangor Hydro Electric Co.; 2 go to Pubblic Service Co. of Oklahoma.
6. Construction going forward on 3500-kw simple, open-cycle GE unit, for oil-burning operation at 1450 F, for Central Maine Power Co.
7. Progress on Allis-Chalmers-Alco and Elliott-Baldwin units for coal-burning gas turbine locomotives of Locomotive Development Committee.
8. Plans reported by Clark Bros., Inc. for a 5750-hp gas turbine to drive a Clark centrifugal compressor on Tennessee Gas Transmission Co. pipe line.
9. Design for an Allis-Chalmers 7500-kw regenerative single-shaft gas turbine unit, for 1300-F inlet temperature and 5:1 pressure ratio, direct-connected to a 3600-rpm generator, for stationary power application. For units up to 15,000 kw, two compressors and a double-flow turbine will be used. Mobile units of 3000 hp have also been designed, Fig. 7.
10. Experimental 200-hp gas turbine for smaller mobile applications,

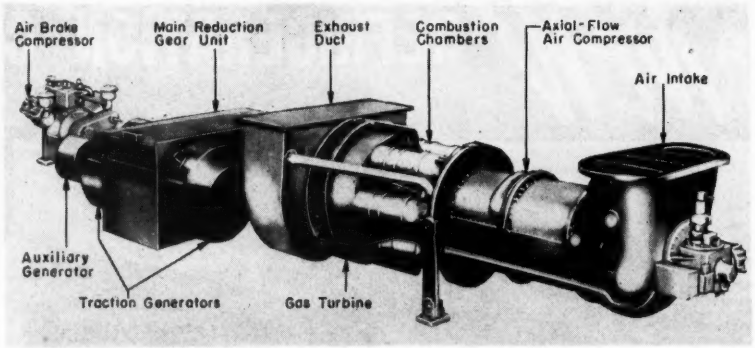

Fig. 4. View of 4800-hp gas turbine power plant of Alco-GE locomotive, Fig. 1 Turbine shaft output 3500 kw; turbine speed 6700 rpm, turbine inlet temperature 1400 F, pressure ratio 5:1; axial flow compressor, air intake rate 80,000 cfm

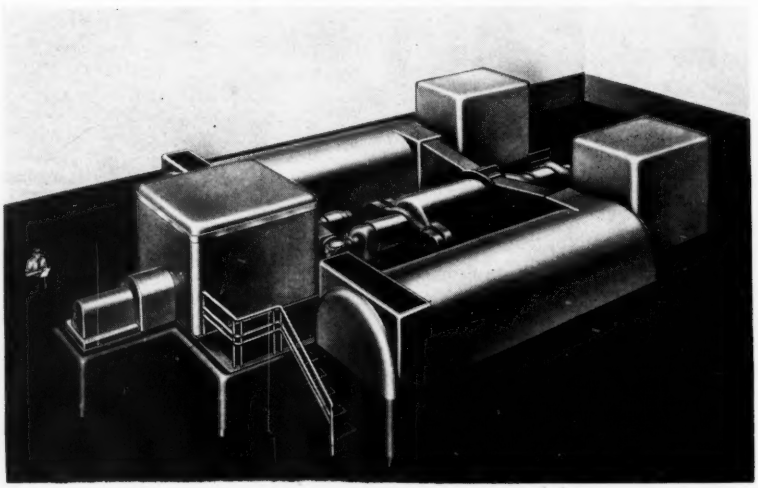

Fig. 5. GE 5000-kw gas turbine generator set ordered for three installations, two for burning natural gas, one for oil. Split turbine design, one turbine driving l-p compressor, other driving h-p compressor and geared generator. Intercoolers between compression stages; regenerator for heating air with turbine exhaust; expected thermal efficiency 28%. Intercoolers and regenerators in two elements each, located with turbine unit on one level

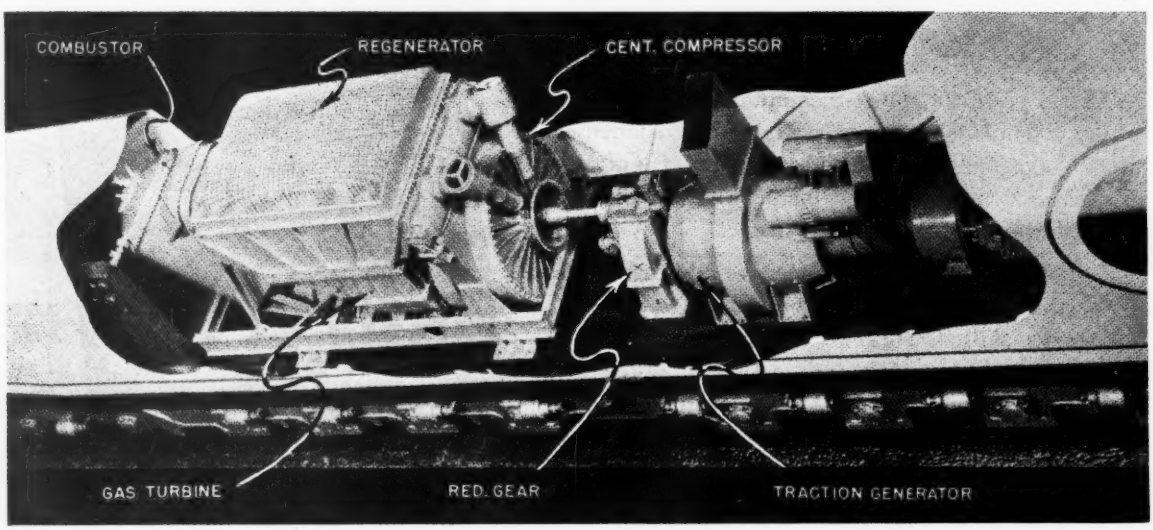

Fig. 6. Elliott open-cycle gas turbine locomotive power plant, 3900 hp., features two-stage centrifugal compressor. Designed for 1275 F turbine inlet temperature, pressure ratio 3.5:1; overall thermal efficiency 25%

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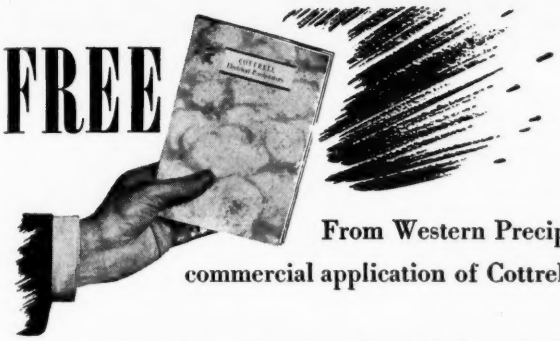

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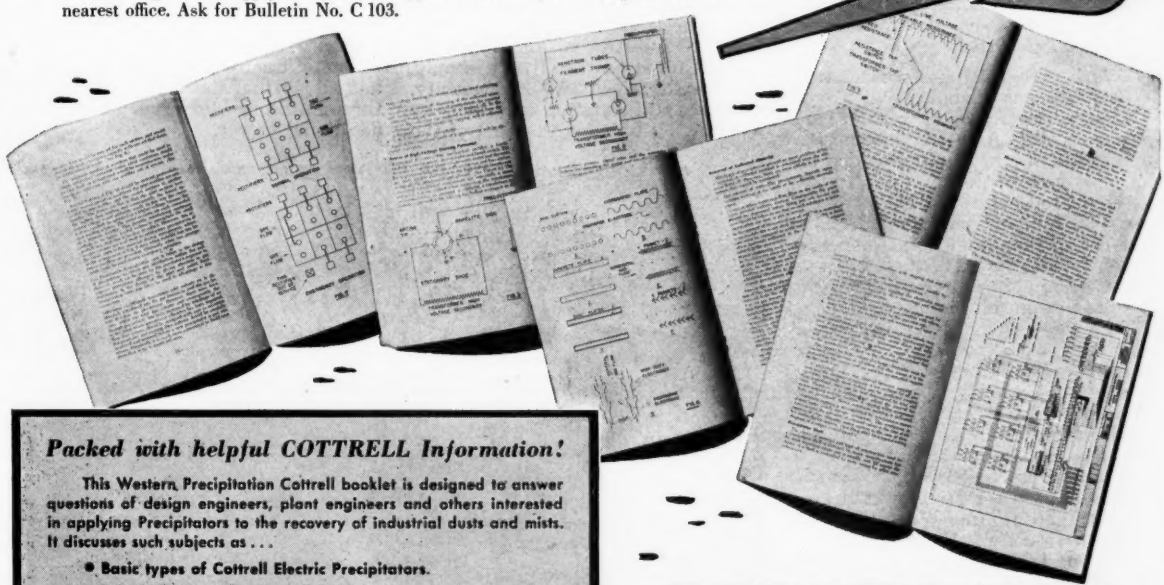

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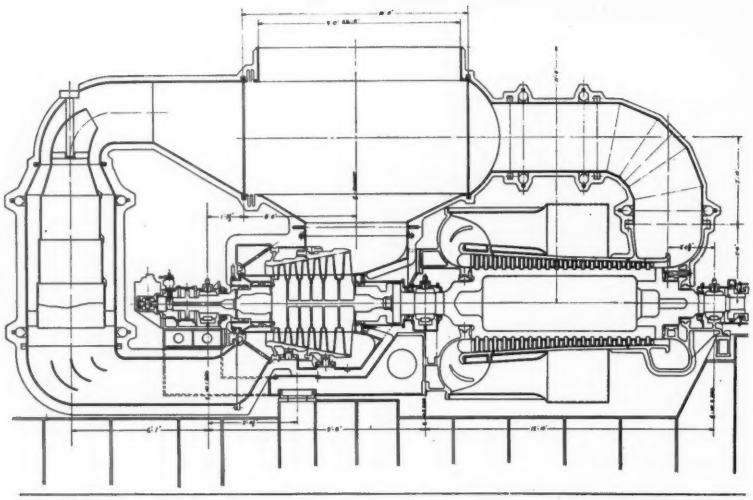

Fig. 7. Allis-Chalmers 7500-kw gas turbine plant for stationary service has regenerator; turbine inlet temperature 1300 F, pressure ratio 5:1, thermal efficiency 22%

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1. Elliott Gas Turbine Developments Applicable to Power Generation; by Edward S. Dennison, Elliott Co.; *AIEE, Feb. 1949*
2. A 3000-hp Gas Turbine Power Plant; by J. S. Haverstick, DeLaval Steam Turbine Co.; *AIEE, Technical Paper 49-113*
3. Operation and Test Experience with an Experimental 2000-hp Gas Turbine; by T. J. Putz, Westinghouse Electric Corp.; *MPC 1948*
4. Gas Turbines in Stationary Power Generation; by F. T. Hague, Westinghouse Electric Corp.; *AIEE Technical Paper 49-115*
5. Two Gas Turbines for Power Generation and Other Applications; by Alan Howard, General Electric Co.; *AIEE Technical Paper 49-114*
6. A 5000-kw Gas Turbine for Power Generation; by Alan Howard and C. J. Walker, General Electric Co.; *ASME Paper No. 48-A-83*
7. A Design of Gas Turbine Suitable for Peak Load and End-of-Transmission-Line Operation; by W. B. Tucker, Allis-Chalmers Mfg. Co.; *AIEE Conference Paper, Feb. 1949*
8. *Gas Turbines and Turbosuperchargers (Basic Information Sources)* Inquiry Reference Service, U. S. Department of Commerce, Washington 25, D. C.
9. Some of the Problems Involved in the Coal-Burning Gas-Turbine Locomotive; by C. K. Steins, The Pennsylvania Railroad; *MPC 1949*
10. Design of a Locomotive Gas Turbine; by W. B. Tucker, Allis-Chalmers Mfg. Co.; *MPC April 1949*

developed by Boeing Aircraft Co.; and announcement in England of a 160-hp gas turbine for automobile drive.

11. Work progressing on DeLaval 3000-hp gas turbine, Fig. 9.

This year's first gas turbine for power is the Alco-GE locomotive unit, Figs. 1 and 4. It provides 53 hp per foot of locomotive length, as compared with the Diesel-electric's 30 hp per foot, and forms a self-contained single-unit electric power plant. It burns fuel oil, the under-frame of the locomotive being designed as an oil storage tank.

The gas turbine is a two-stage unit with six combustors, driving a 15-stage axial compressor and traction generators that supply power to traction motors identical with those used on Diesel-electric locomotives. The gas turbine power plant has a power output of 4800 hp, of which 300 hp is used for auxiliaries, leaving 4500 hp to the generators for traction.

The gas turbine power plant now being installed at the Arthur S. Huey Generating Station of Oklahoma Gas & Electric Co., Fig. 3, is similar in many respects to the Alco-GE locomotive gas turbine plant except that it burns natural gas for fuel instead of oil. It will be the first stationary utility power generating unit to go into operation in the United States. It is a simple, open-cycle unit of 3500 kw capacity. It increases the station capability by 7000 kw, by utilizing the heat of the gas turbine exhaust to heat water in the feedwater heating cycle of the two existing steam turbines in the station. This reduces the amount of steam extracted from the turbines and allows that steam to pass farther through the turbine, thus generating additional power.

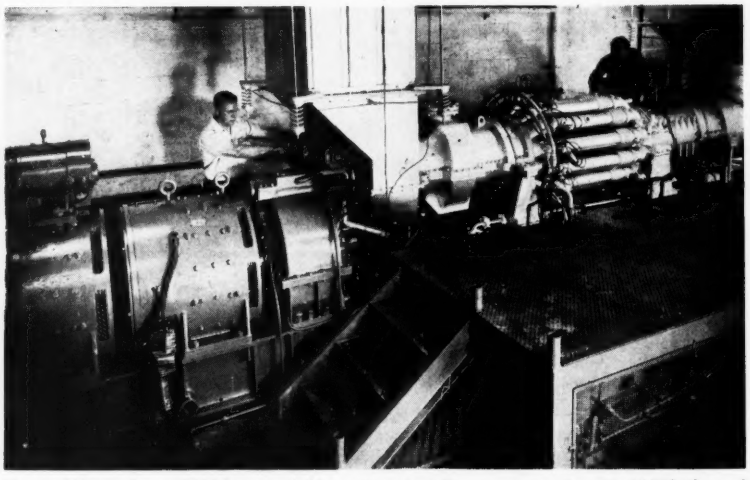


Fig. 8. Westinghouse 2000-hp gas turbine set on test floor; open cycle unit, 16,7% thermal efficiency, turbine inlet temperature 1400 F; will drive compressor on gas pipe line

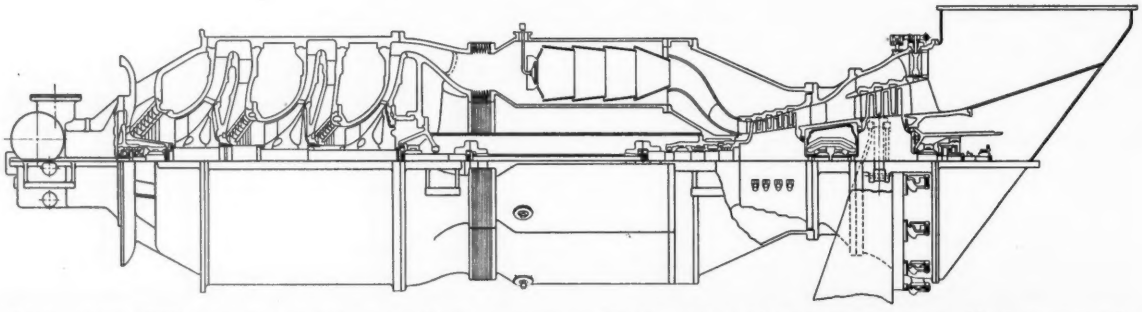


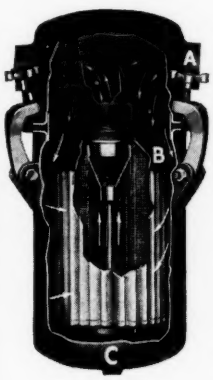
Fig. 9. DeLaval 3000-hp gas turbine; 3-stage mixed-flow compressor; split-turbine design, turbine inlet temperature 1300 F, pressure ratio 6:1; thermal efficiency 17.6%

SCRAM, SCRUD!*

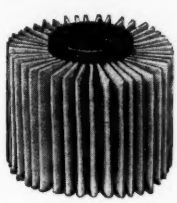
Stay Out of this Vacuum Pump

*Scrud: SCale, RUst, Dirt and other foreign matter in pipe lines

● *Scrud*—a word coined to describe all foreign matter drawn into vacuum pumps—may actually *double* wear on reciprocating parts. This excess wear is caused not only by abrasive particles, but by the washing away of essential lubricants. Staynew Filters *positively prevent* passage of all foreign matter. They frequently save their cost in a few weeks. Good engineering and good business demand Staynew Filters on *all* vacuum lines.



Sectional View of Model CVH



Radial Fin Insert

Operation

Staynew Vacuum Filters clean air by the exclusive Double Action Principle: With filter installed between process and pump, Scrud-laden air enters at (A), striking baffle (B). Here Mechanical Separation takes place, heavier particles of moisture and dirt being driven to bottom of container (C). Then air rises at low velocity thru the Radial Fin Insert which removes the lighter material by Filtration.

All Staynew Vacuum Filters Feature Famous Radial Fin Construction

Radial Fin Construction, an original Staynew development, is the most efficient form ever devised for the removal of foreign matter from pipe lines. Dry-type medium is used, providing positive filtration. *Resistance to flow is low,* due to the large filtering area possible in small space. Filter insert is easily removable and may be cleaned or replaced at low cost.

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Practically any size pipe line or CFM capacity can be accommodated. Standard sizes range from 60 CFM of free air with inlet and outlet connections of 1″, to 825 CFM, connections 8″. Special models are developed when necessary.

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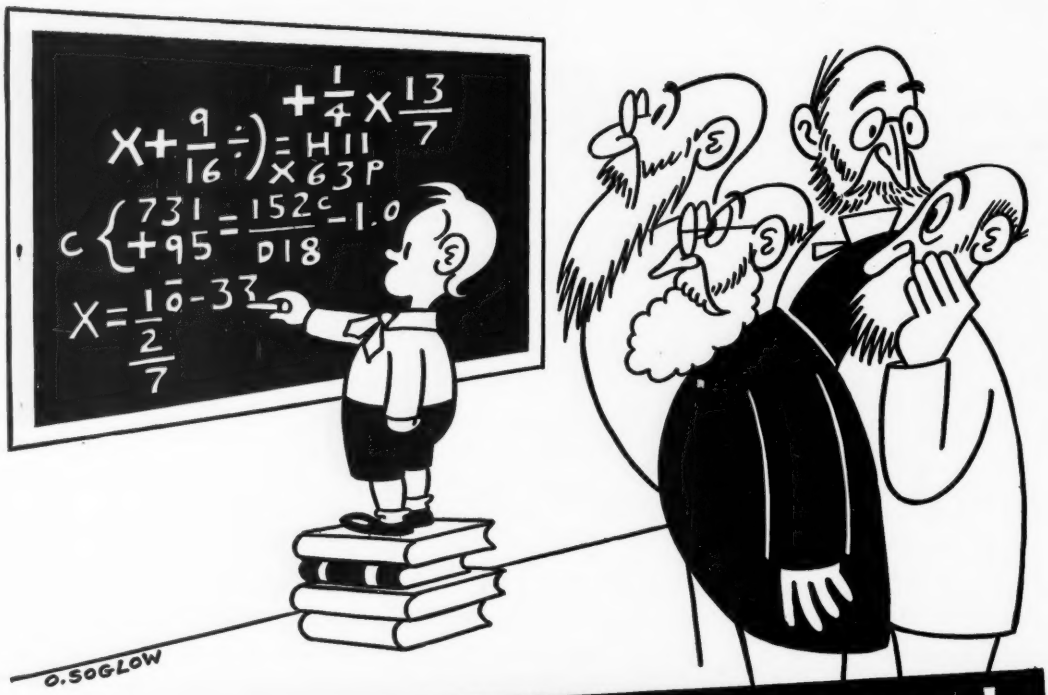

You'll be surprised at these figures!

- 80 million Americans own $48 billion of U. S. Savings Bonds.
- 20,000 of the nation's 38,000 firms employing 100 or more persons are operating Payroll Savings Plans.
- 7,500,000 workers are buying an individual average of $20 of Bonds per month.
- For the year 1948, sales of Series E Bonds *exceeded redemptions* by $495,148,000. The net figure for all Series after redemptions and maturities was $2,151,140,000.

What does all this mean to you? Well, it means first of all that your Treasury Department is successful in its program of increasing the nation's economic security by spreading the national debt. Secondly it means that most of the nation's business leaders recognize the value of the Payroll Savings Plan sufficiently to promote it within their companies.

For example...

To give you some idea of the Plan's growing popularity: 86,384 employees of a prominent electrical manufacturing company were investing in Bonds at the rate of $30,005,270 as of the end of 1948. This is a gain of nearly 100% over 1947, when 45,000 employees participated in that company. The treasurer of a well-known shoe company reported that, of his concern's 19,060 employees, 9,240 were in the Plan and had invested $146,807.32 in Bonds via deductions during the preceding month.

Why promote it?

We all know how buying Bonds builds an individual's future security. But there are *company* benefits too! Nation-wide experience shows that Payroll Savings increases each participating employee's peace of mind—makes him a more contented, more productive worker. It reduces absenteeism, lowers accident rates, increases output, and improves employee-employer relations.

It's easy to boost participation

1. See that a top management man sponsors the Plan.

2. Secure the help of the employee organizations in promoting it.

3. Adequately use posters and leaflets and run stories and editorials in company publications to inform employees of the Plan's benefits to them.

4. Make a person-to-person canvass, once a year, to sign up participants.

These first four steps should win you 40-60% participation. Normal employee turnover necessitates one more step:

5. Urge each new employee, at the time he is hired, to sign up.

Nation-wide experience indicates that 50% of your employees can be persuaded to join—without high-pressure selling. All the help you need is available from your State Director, U. S. Treasury Department, Savings Bond Division.

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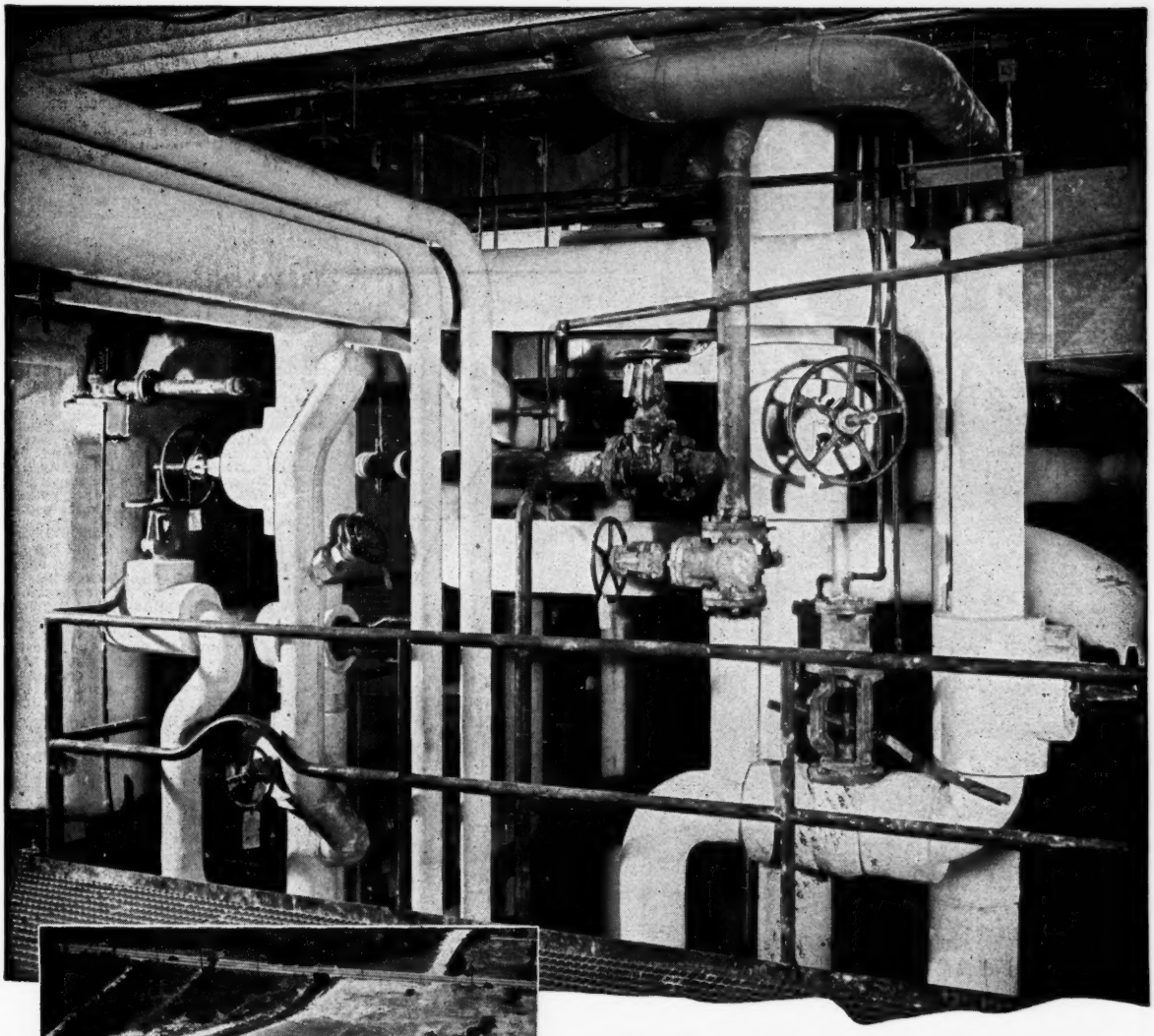

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HELPFUL BULLETINS

(Continued from page 36)

nesia, determination of correct thicknesses, application and finishing precedures, and insulation maintenance. The appendix contains a discussion of practical applications of heat transmission theory, definitions of technical terms, 15 tables of data on this insulation, a glossary of trade terms and a list of trade names of the insulating material and accessory products. The Magnesia Insulation Manufacturers Association.

TREATMENTS, CORROSION PREVENTIVES

131 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

132 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

133 **Corrosion Preventive** — This 4-pp folder on a Vinyl plastic coating emphasizes its value in combatting corrosion of metal, wood, stone, brick and concrete by atmospheric and chemical action. It discusses the characteristics of this preventive, tells how to apply it, recommends applications, and lists substances by which it is not affected. Also describes an underprimer for use with this coating. Dennis Chemical Co.

134 **Metallizing Protection**—Titled, "Stop Corrosion with Metallizing," 8-pp Bulletin 62 is illustrated with many photos showing metallizing applied to tanks, cold plates, fans and filter beds, structural steel and dam gates. It explains how this treatment gives many years of added service life to equipment by protecting surfaces against corrosive agents in salt water and industrial atmospheres. Includes table showing life expectancy of metallized coatings. Metallizing Engineering Co., Inc.

HEATERS

135 **Instantaneous Water Heaters**—Six-pp Bulletin 70 presents detailed information on instantaneous water heaters including capacity and dimension tables for two-pass, four-pass and six-pass designs. A typical piping hook-up for the installation of these heaters is shown. Additional features include instructions for heater selection, engineering data to determine boiler capacities required and an easily-read chart to determine pipe sizes for any steam flow at practical operating pressures. Davis Engineering Corp.

136 **Heater Application Booklets** — Here are five illustrated booklets (6 to 12 pp each) covering major industrial uses of tubular, strip and cartridge heaters. They are intended to show how electric heat, properly applied, can help industry provide better equipment designs and improve product quality. The booklets, all emphasizing the "heat where you want it" theme, include: "Heating Pipelines," (GET 1739); "Melting Soft Metals," (GET 1740); "Heating Process Air," (GET 1741); "Heating Liquids," (GET 1742), and "Heating Surfaces," (GET 1743). Each provides detailed application information, including necessary data and formulae for calculating heat requirements. General Electric Co.

With that pile of paraphernalia up front, no wonder the Indian guide is grumpy. He has no steam power plant to propel that mess of mail order equipment. Oh, how he'd love to give it the water treatment . . . a dunk in the drink would solve *his* problem! • But it takes another kind of water treatment—another kind of HOW—to squelch corrosion, scale and carryover in a power plant. It takes a time-proved, scientifically developed treatment system to reduce down-time for cleaning, repairing and replacement and to maintain high operating efficiencies. • Bird-Archer has been successfully solving water treatment problems for more than a half century. Get the full benefit of this experience by discussing your water treatment problems . . . whether for power, process or cooling . . . with a Bird-Archer Field Engineer.

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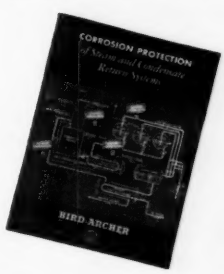

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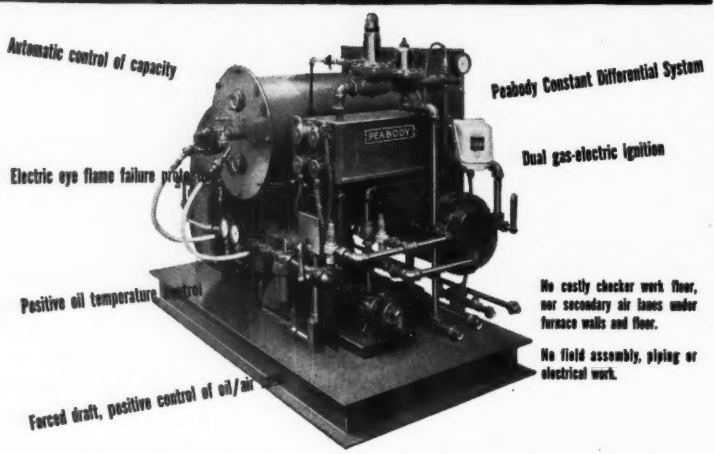
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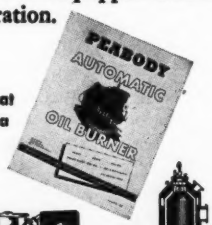

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Blast Furnace Gas Burner Bulletin**—Said to be the first published on the subject. Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

203 **Heat Exchangers Data Book** — Illustrations and pertinent data on the company's complete line of redesigned heat exchangers are presented in Bulletin 1.1K1. This 8-page booklet presents cut-away views illustrating construction and line drawings showing sizes, dimensions and weights. Brief text on various applications of this all-nonferrous unit is presented. Ross Heater & Mfg. Co., Inc.

VALVES, TRAPS, PIPING

204 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card. Pages 35-36.

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C324 ROTOJET Junior Water-driven Motor, univ joint, pivot head

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206 **Steam Trap Catalog** —Thermostatic Steam traps for high pressure industrial service are covered in manufacturer's revised Bulletin 250A, 8 pp. Contains general discussion on these traps, how they're made and how they operate. Includes dimensions, specifications and capacities of traps listed, also prices. Cut-away photos show construction details and sketches show hook-ups. Sarco Co., Inc.

207 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Draining System Bulletin**—Draining and air venting of paper machine cylinders are treated in eight-page Technical Bulletin No. 3. Discusses requirements of an efficient method of draining and air venting dryer rolls and tells how manufacturer's system meets these requirements. Sketches and diagrams show unit and installations. Sarco Co., Inc.

HEATERS, HEATING

211 **Space Heaters**—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

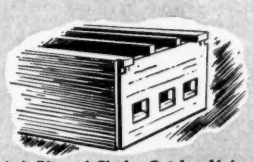
212 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

213 **Heating Element Data**—Bulletin No. 20, 8 pp, contains detailed capacity and dimension tables on manufacturer's "Paracoil" heating elements. Illustrations and descriptions provide instruction for installation of heating elements and diagrams show six commonly used installation arrangements of hot water generation using these heating elements and storage tanks. Includes conversion table for steam and temperature conditions for determining capacity of any size heating element. Davis Engineering Corp.

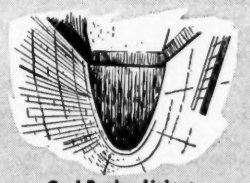
214 **Steam Humidifiers**—Bulletin 1771 describes the company's steam humidifiers for automatically controlling relative humidity for the prevention of dry air damage to hygroscopic materials such as paper, leather, wood, cork, foodstuffs and other materials in storage or in process. The bulletin also describes the effect of relative humidity on human comfort and help and explains how maintenance of proper humidity will eliminate the fire and explosion hazards of static electricity where inflammable dust, vapors or liquids are present. Tables and charts are included on desirable relative humidity in various industries. Two useful sections of

WHERE TO USE LUMNITE IN POWER PLANTS

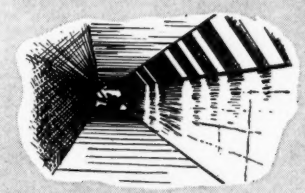
Steel Stack Linings



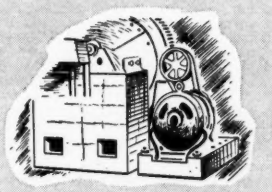
Ash Pit and Cinder Catcher Linings



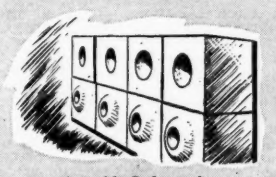
Coal Bunker Linings



Flue and Duct Linings

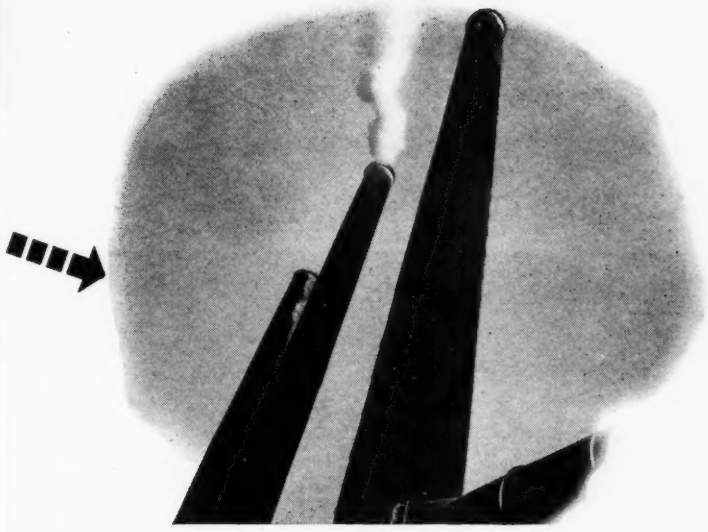


Overnight Structural Concrete



Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperature and insulation needs are made by manufacturers of Refractories, sold by their distributors.



In new stacks or old...

PREVENT CORROSION ...BOOST DRAFTS

with LUMNITE* Stack Linings

LUMNITE adds years of service to old stacks. In new stacks, LUMNITE concrete protects the steel indefinitely.

Steel stacks, new or old, get full protection from corrosion and heat when LUMNITE linings are installed. Linings made with LUMNITE and insulating aggregates boost drafts by keeping gas temperatures up and protect against overloading. They resist attacks of condensate and sulphurous gases and the smooth jointless linings allow no "breathing." In addition, LUMNITE linings in breechings withstand the abrasive action of high-velocity gases and fly ash.

LUMNITE linings are easily installed. Reinforcing mesh is attached to steel angles or other projections welded to the steel shell. The mixture of LUMNITE and insulating corrosion-resistant aggregate is applied over the reinforcing mesh. Maintenance costs are low. Outage time for repairs is kept to a minimum because LUMNITE reaches service strength in 24 hours or less.

Besides stacks and breechings, other power plant installations are listed in the column at left. Depending on requirements, LUMNITE provides high structural strength, high heat resistance and low thermal conductivity. Write for free booklets giving complete information on LUMNITE for stacks, and many other refractory, insulating, corrosion and heat resistant concrete installations throughout the power plant.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PG-L-16

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

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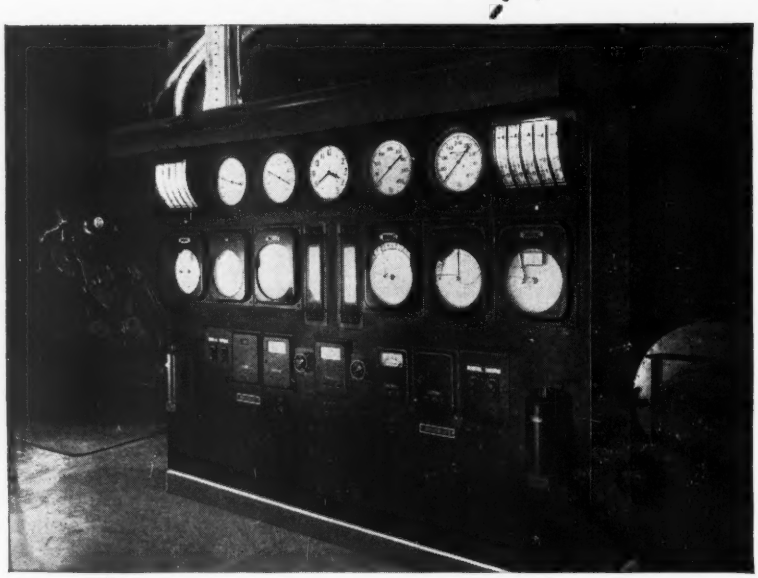
IT HAS MODERN-NESS THAT

STAYS MODERN

"IT'S ELECTRICAL"



There's one sure sign of a truly modern steam plant that will *stay modern* for many years to come: HAYS AUTOMATIC COMBUSTION CONTROL.

No danger here of obsolescence after a few years! . . for Hays control is electrical. It will still be functioning smoothly, automatically — still maintaining combustion efficiency, still saving fuel — after many years of unfailing accuracy.

Look into this modern money-saving system — just as a matter of "good business." Ask Hays users why they prefer it to any other. Inspect Hays installations — notice the orderly neatness of panel interior; observe the absence of involved linkages, piping systems and accessories; see how easy it is to change from automatic to manual control or vice versa by simple operation of a switch.

You'll find Hays' 40-page book No. 47-605 exceedingly worth reading. Better ask for it — no obligation.

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HAYS Automatic COMBUSTION CONTROL

INDUSTRIAL INSTRUMENTS · INDUSTRIAL CONTROL · FLOWMETERS · GAS ANALYZERS · DRAFT GAGES · CO_2 RECORDERS

the bulletin are "How to Select," and "How to Install," both of which are accompanied by excellent line drawings presented in two colors. Armstrong Machine Works.

215 **Tubular Heat Exchangers**—Bulletin 916 is a particularly informative 32 page bulletin which has "just been issued." The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and degrees API. Also presented is a chart of the specific heats of midcontinent crude oils and the charts for solving the MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russel Co.

TREATMENTS, PREVENTIVES

216 **Protective Coating**—Bulletin 1540, 4 pp, is devoted to a corrosion resistant coating for cold, wet surfaces. Tells its protection against corrosive effects of natural fresh and salt water, cold acid and alkali solutions, acid fumes and atmosphere under shelter. Discusses in detail the use of this coating in water storage tanks and in condensers. Tells how coating should be applied and how to order it. Bulletin also includes photos and description of equipment recommended for use in applying the coating. The Dampney Co. of America.

217 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentraion cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

218 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. This is the 10th in manufacturer's series of engineering bulletins. Allis-Chalmers Mfg. Co.

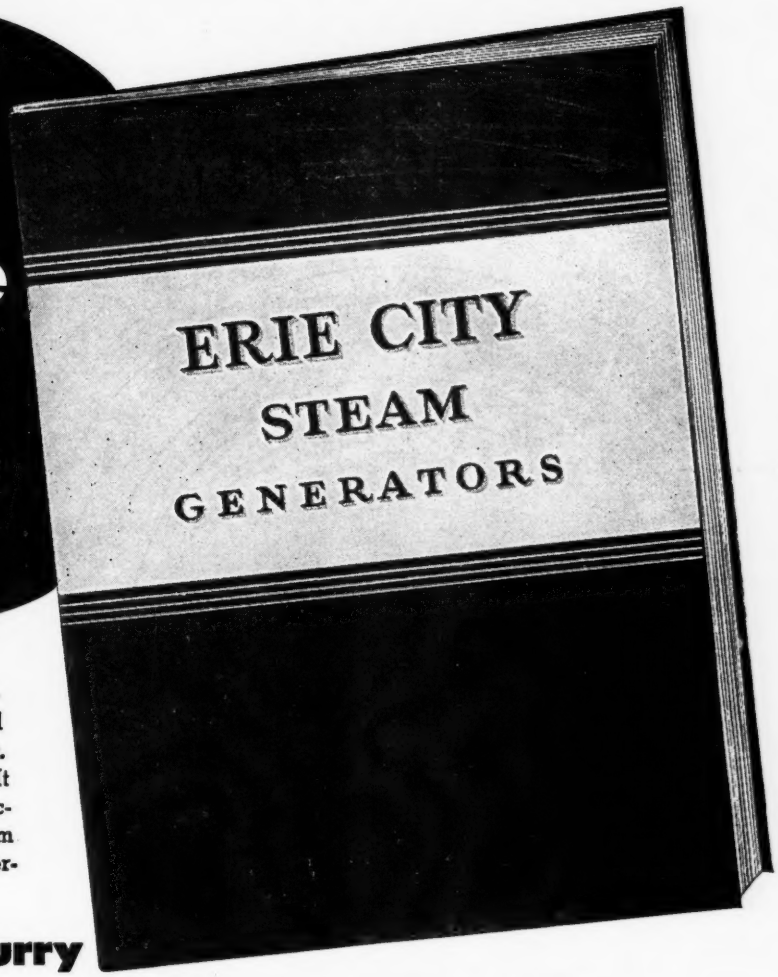
219 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

220 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

221 **Antifoaming Compound**—This new technical bulletin covers the company's latest product known as Antifoam

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card. Pages 35-36.

NEW 40 Page Catalog of INTEREST



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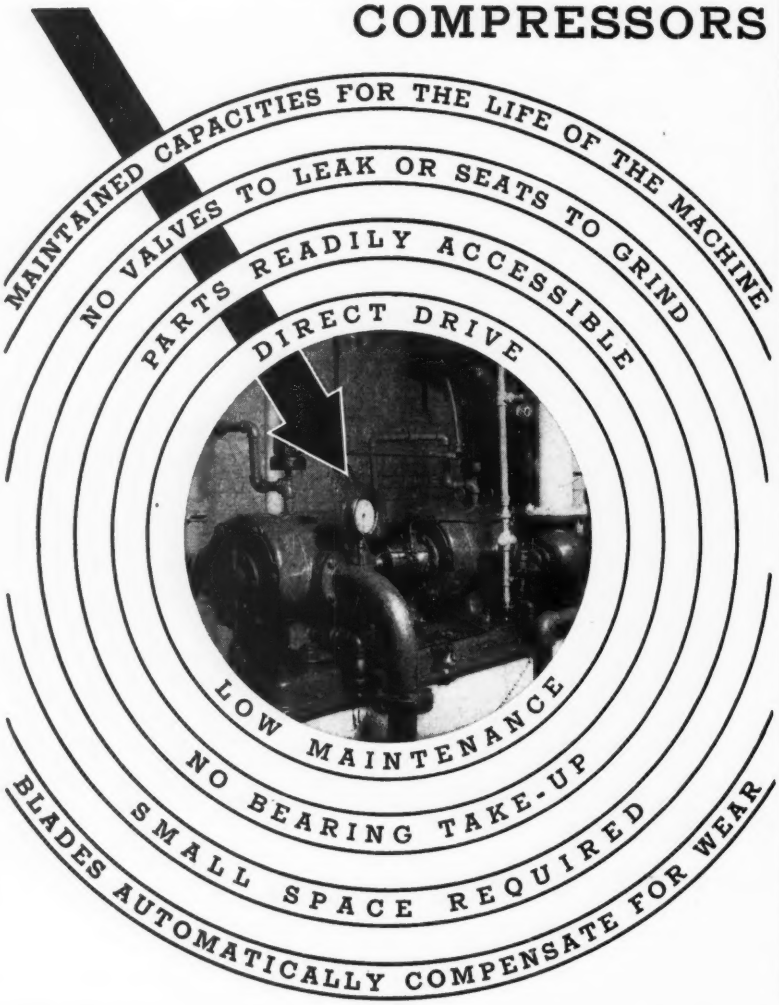
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Fuller Rotary Compressors differ as radically from the conventional type of compressor as a centrifugal pump differs from the old-line piston pump. They have, in a relatively short period, earned a justifiable reputation as a dependable source of air power, with minimum attention and maintenance, together with sustained efficiencies.

They're built for long, continuous service . . . few moving parts: rotor—bearings —blades. Single and two-stage, for capacities to 3300 c.f.m., actual free-air delivery, pressures to 125-lb.

Write for Bulletin C-5, illustrating and describing these machines.

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C-168

FULLER
A LIFETIME OF NEW MACHINE EFFICIENCY

8. With the accelerated rate of operation in many power plants today, foaming from either chemical or mechanical origin has become one of the prime problems in boiler operations. This technical bulletin presents reasons for foaming and deals with the chemical causes, especially the application of antifoams to elimination of carryover from these causes. After discussing the causes for foaming the bulletin goes on to describe the proper dosage and feeding and results obtained from the use of Antifoam 8. E. F. Drew & Co., Inc.

222 Corrosion Resistance of Nickel Alloys—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

223 Magnesium Anode Data—General information on magnesium anodes for cathodic protection of pipe lines and other metal structures is provided in 5 letter-size sheets. It covers applications of cast, packaged, flexible ribbon and extruded anodes. Gives composition of magnesium alloy used and includes ratings, dimensions, sketches and prices. Dowell Inc.

224 Pure Water at Low Cost—The title of this recently issued 20 page booklet is "De-Ionizing Systems for Pure Water at Low Cost." The Booklet is filled with diagrams, descriptions and photographs describing the construction and procedures of the equipment. Flow sheets, excellently done give further information on the use of the de-ionizing systems. One section "Operating Costs" will be of considerable interest to all engineers. Dearborn Chemical Company.

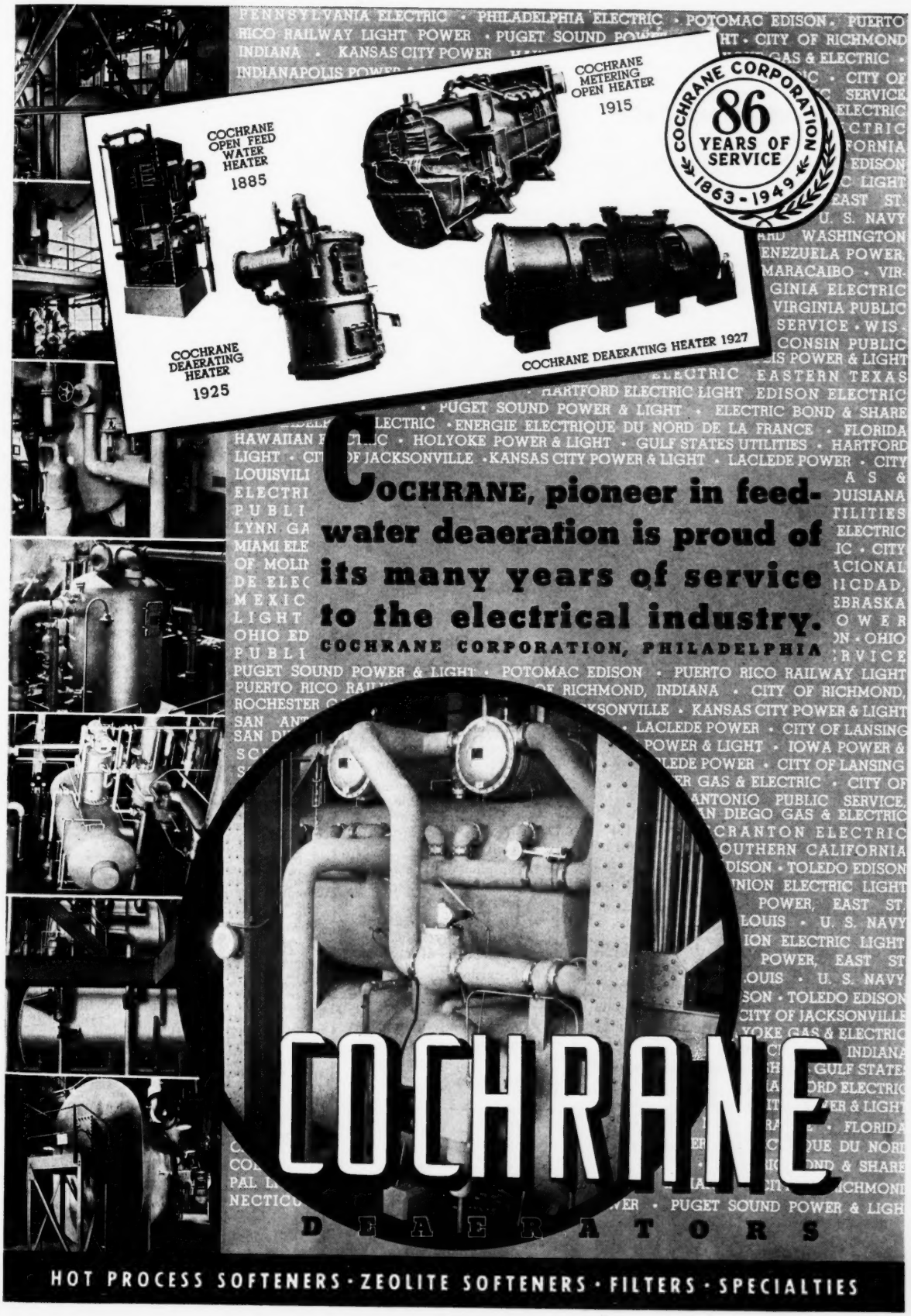
225 Boiler Corrosion—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

226 Application Data Bulletin — Titled "The Aroclors," chlorinated biphenyl and chlorinated poly-phenyls, this booklet describes the unique properties which enables this material to fulfill certain requirements. The Aroclors have won a place in the electrical insulating field and in such widely differing applications as non-flammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes. This booklet contains 28 pages and presents the combined information gathered by the company from what it believes it to be reliable and dependable sources. Monsanto Chemical Co.

ELECTRICAL

227 Electrical Diagram Guide—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and common variations and explains ASA device function numbers and conventions. General Electric Co.

228 Transformer Buyers Guide—An excellent technical manual on instrument transformers is this 80-page catalog, GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.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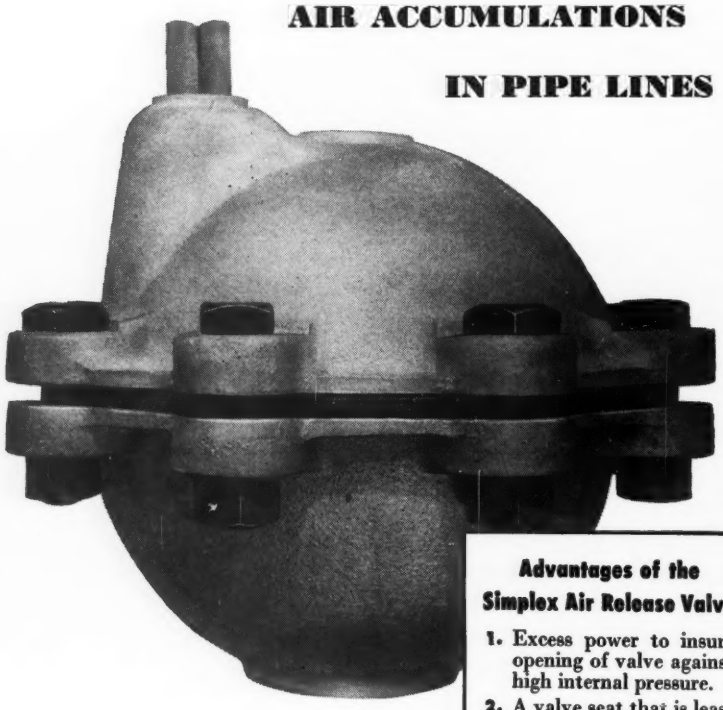
AIR RELEASE VALVES

FOR AUTOMATIC, PERIODIC RELEASE OF AIR ACCUMULATIONS IN PIPE LINES



Advantages of the Simplex Air Release Valve

1. Excess power to insure opening of valve against high internal pressure.
2. A valve seat that is least liable to stick shut or leak water.
3. A non-corrodible float that will not collapse or become disconnected from its lever.
4. Simplicity of construction, easy bearings and few parts.
5. Properly designed outlet port to prevent clogging by deposits of any kind.
6. Provision for draining without dismantling valve.
7. Sturdy construction, permitting rough handling.
8. Easy inspection of internal parts.

Whenever water is forced through pipe lines, under pressure, air in suspension is carried with it.

When air accumulations collect in high points in the line, the usable cross section area of the pipe is reduced and induces a friction factor—lowering the pumping capacity of the entire line.

Simplex air release valves are designed specifically to overcome these conditions and to provide for automatic and frequent release of air accumulations in pipe lines. For full information write to the Simplex Valve and Meter Co., Dept. 7, 6783 Upland St., Philadelphia 42, Pa. Ask for Bulletin 140.

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229 **Induction Motor Bulletin**—A four-page illustrated folder, PB 7000-1, describes manufacturer's new two-pole, 200 to 3500 hp induction motor of fabricated steel construction, available in enclosed or separately ventilated types. Construction features are discussed in detail and illustrated with photographs. Elliott Co.

230 **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

231 **Magnet Catalog**—Twenty-eight page Catalog CDM-2A is a handy ordering guide for stocked permanent magnets of cast and sintered Alnico and special magnetic alloys. Contains photos, dimensions and pull curves of many stocked magnets and drawings of all stocked patterns. Includes tables showing physical properties and tolerances of cast and sintered Alnico, also conversion table. Outlines procedure for requesting magnet design assistance from manufacturer. General Electric Co.

PUMPS, COMPRESSORS, ENGINES

232 **Pumps, Condensers** — This bulletin is a condensed catalog of the products, plants facilities and services of this company. A concise description of the services offered by nine divisions of the company are presented in the bulletin and a summary of the combined services and products offered by the various units is given on one page. A listing of the general maintenance service and bulletins and catalogs available also are presented. A handy cross-index of products in industries served is given in an exceptionally useful cross-indexing chart which occupies a full page. Condenser Service and Engineering Co.

233 **Pump Bulletin**—No. 488, four pages, tells about controlled volume chemical pumps with rotary air or gas motor drives for pumping in small volume or at high pressures, or handling difficult or corrosive materials. Discusses motor feed systems, stroke adjustments and merits of special valve construction, illustrated by cut-away drawing. Technical information capacity pressure selection table and diagrams showing pump installation and automatic pH control system. Milton Roy Co.

234 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

235 **Air Compressor Lubrication Manual**—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

236 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as

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giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

237 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

INSTRUMENTS AND CONTROLS

238 **Recording Instruments Data Book**—A new oxygen analyzer—based on the paramagnetic property of oxygen—is introduced by description and illustration in Bulletin 48-829, 16 pages. Tells advantages and applications of new instrument. Also treats in detail the manufacturer's long-established analyzer for carbon dioxide and other gases, as well as an electronic recorder (which records temperature and pressure, too) for use with the analyzers. Includes discussion of several recommended gas sampling systems. The Hays Corp.

239 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

240 **Temperature Measuring Instruments**—For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

241 **Combustion Control**—Bulletin 102-D describes this company's air operated combustion control. Containing 32 pages and bound in a heavy paper cover, the booklet describes completely the application to boilers fired with oil burners, stokers, to furnace draft control and points out its adaptability to any plant layout. Descriptions of the controllers themselves along with integral parts of the units are given. Typical installations of pulverized coal fired boilers are presented in a separate section of the bulletin. Installations on stoker fired boilers and on oil fired units also are given. Bailey Meter Company.

242 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

243 **Multiple Signal and Alarm Systems**—Panalarms, multiple signal and alarm systems adaptable to all types of industrial and power plant applications, are described in 12-page, letter-size, illustrated Series 300 Panalarm bulletin. Gives details of operation, shows types for panel and well mounting, wiring circuits, operation sequence, dimensions of units. Shows how Panalarms indicate by light and horn signals, acknowledging button, for normal and abnormal conditions. Systems are supplied in multiple units up to 12 in single cabinet; extra space for spare units; provisions for future additions; simple field wiring. Price list included. Panalarm Products, Inc.

244 **Instrument Handbook**—"Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and sizes and prices given. W. A. Taylor & Co.

DUST COLLECTING

245 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

246 **Automatic Filter Bulletin** — A new model 4-stage automatic self-cleaning filter for handling large air volumes and heavy dust loads is introduced in this 8-pp bulletin. It lists important advantages offered by this filter, tells its applications and describes its construction and operation. Includes specifications, performance data and shipping weights. Illustrations include photos of the filter and parts, and a cross sectional layout of equipment used in central air conditioning. Dollinger Corp.

MATERIALS HANDLING

247 **Continuous Weighing of Dry Materials**—Bulletin E4-550 describes the company's new meter for continuously weighing and totalizing the flow of dry

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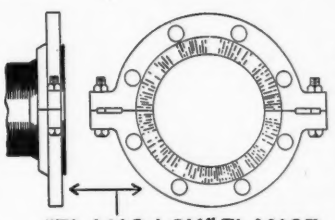
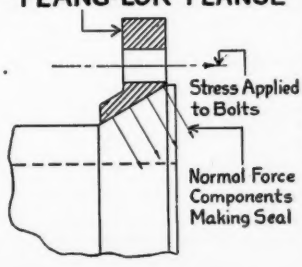


"FLANG-LOK" FLANGE



For all standard pipe sizes from 3/8" to 96" I.D., on fluids or gases under vacuum or pressure, at temperatures up to 250° F.

Quickly, easily installed with "FLANG-LOK" FLANGES. Split flange accommodates flared end of joint. Turn flange only (not joint or pipe) to align bolt holes with connecting flange.

Leakproof, rubber-cushioned seal. As bolts are tightened, rubber end of joint is compressed over broad area against connecting pipe. Magnitude of forces forming seal is in direct proportion to stress applied to bolts.

Superior strength, durability, safety. Special built-up construction, employing rubber, duck and metal, assures widest margin of safety against rated pressures.

Plain, efficient operating principle. All movement occurs in center corrugation. Width of corrugation determined by extent of movement required. Phone our nearest branch for further details or write for illustrated folder.

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We make them for all boiler room conditions.

All are hydraulically operated.

Bulletin No. 4-A—our 20-page Data and Price Book on Damper Regulators shows:

No. 501. For low pressure heating boilers.

No. 501—Compensating. Same as above but with Compensating Attachment. Pressures from 5 to 25 pounds.

No. 501-8. For vapor and low pressure heating boilers. Atmosphere to 5 lb. pressure.

No. 502. For boiler pressures up to 150 lb.

No. 503. Cast iron base construction suitable for pressures up to 250 lb. Cast steel base construction suitable for pressures up to 400 lb.

Bulletin 4-A explains in full what ATLAS damper regulators do and why hydraulic operation is best. Drawings show all parts and how the regulators are constructed. Drawings also show typical hook-up arrangements.

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materials on conveyor belts. The meter can also be used for the automatic proportioning and controlling of dry or liquid feeders for secondary ingredients. The bulletin describes how the device operates, how it is constructed and gives various features. A double page spread, printed in two colors, presents a typical installation of the unit on a belt conveyor. Blueprint type drawings illustrate various applications for the continuous weighing and/or controlling and proportioning and flow of dry or liquid materials. Builders-Providence, Inc.

248 **Dry Materials Conveyor** — Bulletin F-H-1 describes this company's revolutionary type of conveyor designed for the handling of fine, dry materials. The book, which contains 12 pages, presents excellent installation views of the conveyor, and also drawings which illustrate construction and method of operation. The bulletin points out that the conveyor has no moving parts and that it has no hazards to workmen, is silent in operation, requires no lubrication and can pass around obstacles. Fuller Company.

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249 **Refrigeration Condenser Catalog** — Designated as Bulletin RC-1, this 24-pp illustrated catalog covers ammonia and freon refrigeration condensers of horizontal and vertical construction. Includes specifications, dimensions and applications according to type. Lists weight and prices of available models and includes property tables for refrigerants and safe external working pressures for steel tubes. Sketches and line drawings show construction details and arrangement of units; photos show many installations. Henry Vogt Machine Co.

250 **Industrial Insulation Catalog**—Mineral insulations for practically every purpose are covered in this 20-pp illustrated catalog. It describes in detail insulating cements for both high and low temperatures, high temperature block insulation, block finishes, felts, blanket insulation, pipe coverings, loose wool, weatherproofing and stack paints. Includes information and what each class of insulation is for, what it can be expected to do, how it's applied, how it's packaged and, in most cases, how much it costs. Discusses requirements of a good insulation and tells how these products meet the requirements. Forty-Eight Insulations, Inc.

251 **What's Your Cooling Tower I. Q.?** —Here is a chance to score your knowledge. This company, a manufacturer of cooling towers and spray nozzles, has prepared a series of question and answer type monthly mail pieces with the title as given above. The first of the series deals with water distribution; the second, air movement; the third, facts and figures, etc. Although the subject is technical, presentation is informal and attractively illustrated and makes for enjoyable reading. At the same time the pieces are informative enough to merit serious study and a place in the permanent files of most engineers. The Marley Co., Inc.

252 **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

253 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Company.

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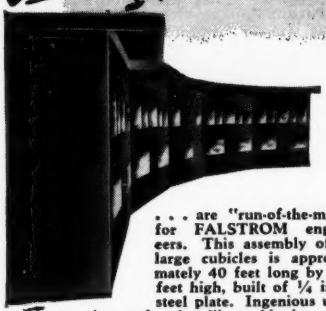

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New ENGINEERING BOOKS

Standard Handbook for Electric Engineers, by Archer E. Knowlton, Editor-in-Chief; eighth edition; size 6½ by 9¼ in., 2311 pages; illustrated; bound in flexible fabricoid; published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 18, N. Y.; 1949. Price $12.00.

This eighth edition of the Standard Handbook for Electrical Engineers is the first published since the beginning of the war. The seventh edition was published in August 1941. Technological development is always accelerated by the pressure of war and this is reflected in this new edition of this widely accepted handbook of the electrical arts.

The Standard Handbook is the combined work of over 100 electrical engineering authorities. Its 2311 pages include facts, figures, systems and measurements, materials and methods, authoritative standards, development in equipment and methods from all fields of electrical engineering. As in the case of the previous edition, the book was compiled under the editorship of A. E. Knowlton. He was assisted by R. M. Shoop, both on the editorial staff of the Electrical World.

The Handbook's 26 sections reflect the tremendous strides made by the electrical engineering profession in recent years. All important developments are included. Radar and associated microwave techniques, nuclear energy, induction and dielectric heating, new elastomers and plastics, new standardizations, etc. The new eighth edition features a complete recasting of materials on conductors, a revamping of the section on generators and transformers, a conciseness and clarity that makes every section an orderly compilation of working-tool information.

The following representative section heads indicate the great scope of the new Handbook: illumination; industrial and commercial power; electric heating and welding; wiring design—commercial and industrial buildings; electronics and electron tubes; codes and standard practices; prime movers; power distribution; properties of materials; electro chemistry; and electro metallurgy.

A most valuable part of the book is the comprehensive index. Further expansion of the index was given concentrated attention with the objective of leaving no significant item unidentified as to the location in the book. Particular attention also was taken to record credits to sources of information. The book is authoritative in every way and it deserves a place in the library of every electrical engineer.

• • •

Industrial Electricity, Volume II, Alternating Currents, by William H. Timbie and Frank G. Willson; First Edition; size 6 by 8¾ in., 781 pages; illustrated; cloth. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1949. Price $5.90.

This book is a study of alternating current theory and practice as applied in modern industry. It is Volume II of a Course in Industrial Electricity, the first volume of which is devoted to direct current practice. It assumes that readers are familiar with the material in Volume I or that contained in similar textbooks.

The authors' purpose has been to give the user of this volume a thorough knowledge of the fundamentals of alternating current both in practice as well as theory. First, they take up what happens and follow this with why it happens. The reader has the advantage of seeing an application of a particular principle and immediately thereafter, has the principle itself explained. The illustrations greatly simplify understanding of the abstract principles that follow.

After theory, come examples which take up other applications and following the examples, are problems which the student must work out for himself. These require a knowledge of simple algebra and arithmetic only. The few trigonometric equations used are explained in three pages of one of the appendixes. This system is used because unless the student is thoroughly familiar with higher mathematics, he must devote his entire attention to mastering them and, hence, will lose sight of the original purpose of his study.

While the book is designed as a textbook, it is, of course, of equal value to any engineer who wishes to enlarge or refresh

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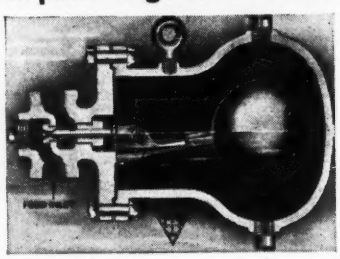

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his knowledge of alternating current phenomena.

The authors have had long experience instructing electrical engineering students. William H. Timbie was for 28 years Professor of Electrical Engineering at M.I.T. and in charge of the cooperative courses in Electrical Engineering which he inaugurated there.

The late Frank G. Willson was educated at Montana State College and the University of Wisconsin and, for many years, was Head of the Department of Applied Electricity at Wentworth Institute, the position which he held at the time of his death in 1947.

• • •

Patent Law by Chester H. Biesterfeld. Second Edition; size 6½ by 9¼ in.; 267 pages; cloth. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1949. Price $4.00.

This is a book for lawyers, students, chemists and engineers. In this second edition, as in the first, it has been the author's endeavor to present a volume on the patent law that fulfills three purposes—first, a volume of modest size; second, a text that presents the basic principles of the substantive patent law in terms that the general reader will be able to understand; and third, a careful selection from the leading decisions in support of these principles, especially the citation of pertinent passages from the decisions of the U. S. Supreme Court and the decisions of the federal courts of appeals during the last ten years or so.

For those familiar with the first edition, the second edition has undergone extensive revision. There has been an addition of recent decisions arranged in groups to illustrate the various phases of the subject of invention according to the modern ideas of the courts. The chapter on "Uses" is entirely rewritten with a more complete list of authorities; also, an article on "Products of Nature" has been added. The discussion of "Double Patenting" is restated and that of "Disclaimers" has been redrafted in view of new decisions. In the chapter on "Infringement" an extensive insert presents the Supreme Court cases on the interpretation of patent claims.

A word about the author. Mr. Biesterfeld has had wide experience in the field of which he writes, working in both the engineering and legal end. From 1926 to the present time he has been head of the patent department of E. I. du Pont de Nemours & Company, Inc.

• • •

Basic Electrical Engineering by George F. Corcoran. First Edition; size 6 by 8¾ in.; 450 pages; illustrated; cloth. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; 1949. Price $4.50.

Of the many outstanding features of this book, one of the most important is the simple and direct method by which magnetic field concepts are handled. Rare, indeed, is the textbook of electrical engineering which maintains throughout a level suitable for beginners. This book does just that.

For example, each electric or magnetic concept is exactly defined at the place of its introduction. There, also, its relationship to previously considered quantities is discussed. Throughout the theoretical development of the subject the rationalized mks system of units is employed. This permits use of the ampere term as the principal unit of magneto motive force.

Arrangement of the subject matter is likewise planned to suit the beginning course. First, D-C theory is considered with D-C circuit analysis by the mesh and nodal methods. This is followed by electric field theory, magnetic field theory, inductance, capacitance, and non-linear circuit elements.

Magnetically generated voltages and magnetically developed forces are reduced to simple mathematical corollaries of basic definitions. There is a wide range of problems with each chapter, and the entire text is extremely well-illustrated.

The author has been Professor of Electrical Engineering and Chairman of the Electrical Engineering Department of the University of Maryland since 1941. In all, he has had over 20 years of teaching experience having been on the faculties of the University of Minnesota, Kansas State College, and the University of Iowa, before going to his present position.

• • •

The Science and Engineering of Nuclear Power, Volume I and Volume II, edited by Clark Goodman. First Edition; size of both volumes 8¼ by 10½ in.; Volume I, 536 pages; Volume II, 342 pages. Both volumes bound in cloth and fully illustrated. Published by the Addison-Wesley Press,

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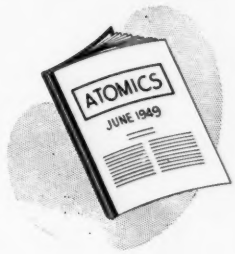

ATOMICS is published monthly for engineers. The timely articles appearing in each issue are essentially practical in nature—written for the average engineer rather than nuclear physicists. Andrew W. Kramer, the editor-in-chief of ATOMICS has been a pioneer in interpreting and translating the complex, highly technical material issuing from the laboratory into language any engineer can understand.

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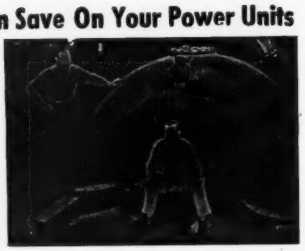

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Inc., Cambridge 42, Mass.; 1947. Price of each volume $7.50.

These two volumes unquestionably represent the most complete and authoritative information on the science and engineering of nuclear power available to the general engineering public at the present time. All the material in the two volumes has been submitted to the U. S. Atomic Energy Commission for review by its Declassification Office and the Commission has approved publication from the standpoint of security.

The material in these volumes contained the essentials of a series of seminars initiated at the Massachusetts Institute of Technology in October 1946. The objective is to present the fundamentals of chain reacting systems in terms that are understandable to the non-specialist, particularly to engineers interested in the industrial applications of nuclear energy. Progress in this field requires the coordinated effort of many branches of science and engineering, particularly during the next several years. Gradually the responsibility will develop to a new breed of specialists already dubbed "nuclear engineers." It is anticipated that collaborated publications of this type will assist materially in these developments.

Edited by Clark Goodman, the volumes, of course, constitute the combined efforts of a large number of nuclear physicists working in this field. Volume I is primarily a general survey of the fundamentals of chain re-acting systems. An idea of its contents may be had from the following chapter headings: (1) Fundamentals of Nuclear Physics; (2) The Fission Process; (3) Neutron Diffusion; (4) Nuclear Chain Reactions; (5) Elementary Pile Theory; (6) The Application and Experimental Basis of Pile Theory; (7) Chemistry of the Fission Process; (8) Control and Operation of a Pile; (9) Construction of Nuclear Reactors; (10) Heat Transfer; (11) Heavy Elements and Nuclear Fuels. Volume I concludes with a number of appendixes containing essential data.

Volume II considers the specific aspects of all these subjects in considerably greater detail. The chapter headings of Volume II are as follows: (1) Source Materials for Nuclear Power; (2) Isotope Separation; (3) Vacuum Techniques in Nuclear Engineering; (4) Theoretical Basis of Some Measurements Useful in Pile Design; (5) Research in Neutron Physics at Chalk River; (6) Calculation of Neutron Distribution in Heterogeneous Piles; (7) The Concept of Albedo in Elementary Diffusion Theory; (8) Pile Kinetics; (9) Statistical Aspects of Pile Theory; (10) Heat Removal from Nuclear Reactors; (11) Rockets and Other Thermal Jets Using Nuclear Energy; (12) The Shielding of Nuclear Reactors; (13) Effects of Radiation on Materials; (14) Production of Radionuclides; (15) Pile Materials; (16) Health Physics; (17) Future Developments in Nuclear Energy.

In view of the limited amount of material available up to the present time, the publication of these books is extremely welcome. Their value to engineers interested in applications of nuclear energy in any of its phases cannot be overestimated. The great amount of detailed information in these two volumes and the additional fact that they have been approved by the United States Atomic Energy Commission, should be sufficient proof that atomic secrets are largely figments born in the minds of well-meaning persons who happen to be ignorant of this special field.

Of interest is the disposition of royalties from the sale of these two volumes. Since much of the scientific and technical content was derived from many sources and was developed with public funds, it seemed inappropriate for the authors and editor to receive any remuneration. Accordingly, the monies thus derived are being used for the furtherance of international goodwill by contributions to the selected scientific activities whose supporters find it difficult to obtain financial assistance.

• • •

Smoke by Arnold Marsh. First Edition; size 6 by 8¾ in.; 306 pages; illustrated; cloth. Published by The Sherwood Press, P.O. Box 566, Pacoima, Calif.; 1948. Price $7.00.

In Great Britain, as well as in this country, smoke from industrial and household chimneys has for long been recognized as a serious menace to health and to urban amenities, as well as a heavy economic burden to the nation. Its presence is also proof that a great deal of coal is being wasted and the case for smoke prevention is becoming more and more closely linked with the urgent drive for fuel efficiency and the long-term question of coal conservation. There is also

a growing realization that reconstruction and new building, including housing, can be planned for smokelessness.

Papers and pamphlets on the many aspects of the smoke problem have been numerous, but text-books, giving a general account of the causes and consequences of our polluted atmosphere, and with a policy for ending it, have been few. Such a book, up to date and surveying all the principal factors involved, has been needed, particularly at the present time when public interest is rapidly growing and programs for progress are beginning to take shape. This book is an attempt to meet this need. It is hoped that it may combine interest to the general non-technical reader who approaches to the subject for the first time, and that it will be of assistance to those who are concerned with it more closely.

Mr. Arnold, the author, is General Secretary and publications editor of the National Smoke Abatement Society in Great Britain. He presents an up-to-date and comprehensive survey of all the principal aspects of the problem: the causes and nature of smoke and other atmospheric pollution, its behavior and consequences, and its relation to the coal problem. Although written from the standpoint of Great Britain, the book is of equal value to readers in the United States.

• • •

Elements of Applied Hydrology by Don Johnstone and William P. Cross. First Edition; size 6½ by 9¼ in.; 276 pages; illustrated; cloth. Published by The Ronald Press Company, 15 East 26th St., New York, N. Y.; 1949. Price $5.00.

Hydrology in a broad and literal sense is the science treating of water, its properties, phenomena, and distribution. For engineering purposes, however, hydrology may be taken to be the science dealing with the occurrence and movement of water upon and beneath the land areas of the globe. With this definition, we may think of hydrology as being bounded above by meteorology and below by geology, and at land's end by oceanography, but with lines of demarcation that are by no means distinct.

The purpose of this book is twofold: (1) to set forth some of the fundamentals of the subject and (2) to encourage an analytical approach to the solution of engineering problems in general. Although the book is designed essentially as a textbook, it should be of general interest to all engineers concerned in some degree with the movement of waters upon the earth. As the authors point out, there was some difficulty in preparing the text in adjusting it to a suitable undergraduate level of facility in hydraulics and mathematics. As far as hydraulics is concerned, the authors have assumed that the student is not acquainted with the concepts of nonuniform flow and nonsteady flow but that his foundation does include the Bernoulli theorem, the general concepts of uniform flow in open channels, and the concepts of depth and energy gradient. For mathematical background, the authors have assumed nothing beyond elementary calculus and a general acquaintance with the concept of least-squares adjustments.

Don Johnstone is Assistant Director of W. C. Kruger and Associates, Architects-Engineers, Inc. of Los Alamos, New Mexico. William P. Cross is Hydraulic Engineer, Water Resources Division, United States Geological Survey at Columbus, Ohio.

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Elements of Mechanical Vibration by C. R. Freberg and Emory N. Kemler. Second Edition; size 6¼ by 9 in.; 227 pages; illustrated; coth. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; 1949. Price $3.75.

The purpose of this book is to present in detail the more elementary stages of vibration and to reduce them to a form in which they can be applied to practical problems. As pointed out by the author in the preface, while there are many problems in the field of vibration which can be solved only by using the methods of advanced mathematics, there are many problems which can be solved by using the simpler forms of differential equations, the approximate methods developed, or the mobility method. These methods of solution can be mastered by engineers and students without training in advanced mathematics.

With these ideas in mind, the text has been kept as simple as possible and examples have been included to illustrate the methods, units, and application of the formulas developed.

This second edition is distinguished by the addition of two new and important chapters: Sound and Beams. The increased

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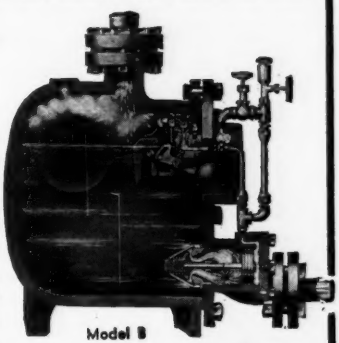

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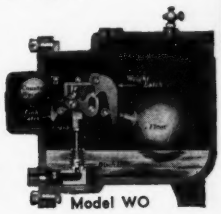

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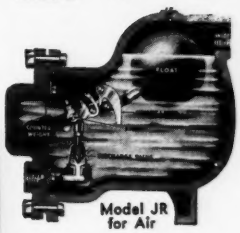

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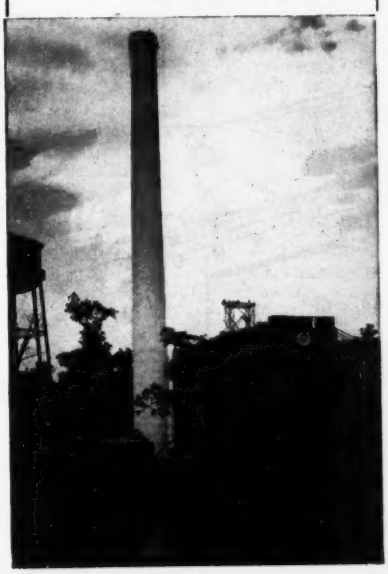

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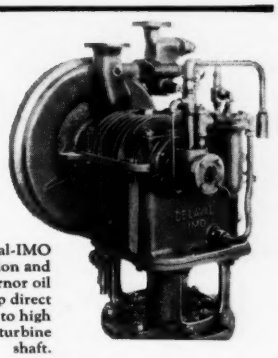

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emphasis which engineers must give to noise elimination lead to the inclusion of the chapter on sound and its engineering application. Since beams are a very common structural element, they have been given additional emphasis by combining the previous discussion with new material and presenting it as a separate chapter.

C. R. Freberg is Head of the Engineering Division of Southern Research Institute and E. N. Kemler is Research Professor of Mechanical Engineering and Assistant Director of Research at the College of Engineering, New York University.

• • •

Basic Electrical Engineering, by George F. Corcoran. Size 6 x 9 in.; 440 pages plus index; cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Ave., N. Y. City. Price $4.50.

This is a textbook designed especially for use in an introductory course in electrical engineering. Fortunately, this book handles magnetic field concepts by a simple and direct method. For example, each electric or magnetic concept is exactly defined at the place of its introduction. There, also, its relationship to previously considered quantities is discussed. Throughout the theoretical development of the subject, the rationalized mks system of units is employed. This permits use of the ampere-turn as the principal unit of magnetomotive force.

Arrangement of subject matter is likewise planned to suit the beginning course. First, direct-current theory is considered, with direct-current circuit analysis by the mesh and nodal methods. This is followed by electric field theory, magnetic field theory, inductance, capacitance, and nonlinear circuit elements.

• • •

Patent Law for the Executive and Engineer, by Harry Aubrey Toulmin, Jr.; Size 5½ x 8 in.; 232 pages; cloth bound. Published by Research Press, Inc. Price $2.95.

This book is an essentially practical treatise on the correct procedure for getting a patent. Not only does it serve as a guide for the individual inventor, but it also tells company management how to stimulate invention by employees, how to avoid patent infringement, and how to protect research profits.

In the very first chapter of this book, the author has summarized the advantages to the American system of the patent monopoly, "the only monopoly approved by the United States Government." In brief form, he discusses the step-by-step patent application and describes the advantages and privileges of the patent holder. The services of a patent attorney are described and the author points out just when to consult a patent attorney. Furthermore, he discusses the relative merits of protection by trade secret or patent.

Discussed in considerable detail is one of the little-known phases of patent protection—the ability to prove that certain events happen on certain dates. The successful prosecution or defense of a patent suit often depends upon properly kept invention records.

The author of the book is a corporation lawyer; he has represented hundreds of corporations in patent work, including many of the leading companies. As an industrialist, inventor, and a head of a large industrial research laboratory, and as a trial patent lawyer, he has had thirty five years experience.

• • •

National Conference on Industrial Hydraulics Proceedings, 1948; size 6 in. by 9 in.; 154 pages plus registration lists. Published by National Conference on Industrial Hydraulics, Armour Research Foundation and Graduate School, Illinois Institute of Technology, Technology Center, Chicago 16, Illinois. Price $3.00.

These Proceedings contain several papers all of which were presented at the 1948 National Conference on Industrial Hydraulics. Among the papers are "The Poly-phase Torque Converter" presented by Oliver K. Kelly with discussions by G. W. Pontius, V. J. Vandasek, E. F. Farrell; "Hydraulic Circuits for Farm Tractors" by J. F. Ziskal: "Flanged Joints —Their Development and the Trend" by E. G. Schmidt; "Hydraulic Packings and Seals" by C. E. Schmitz; "Gasket Design and Selection" by H. H. Dunkle; plus several others.

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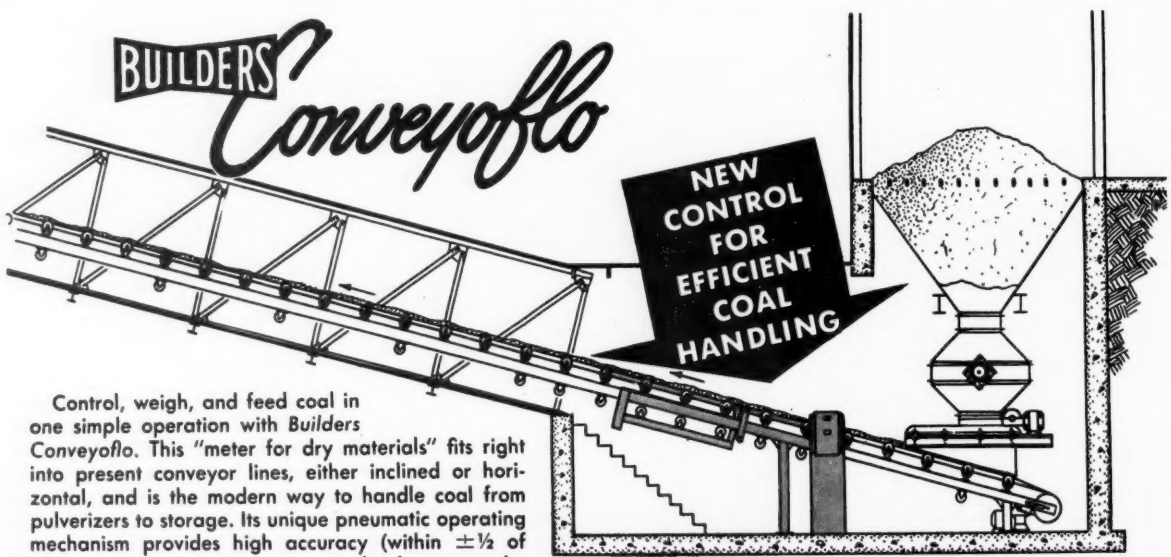

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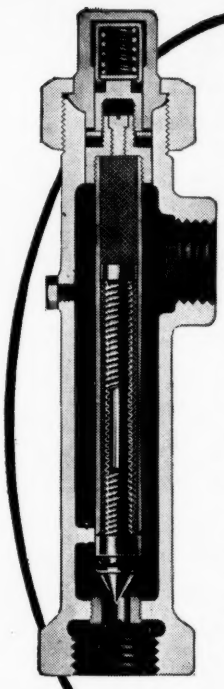

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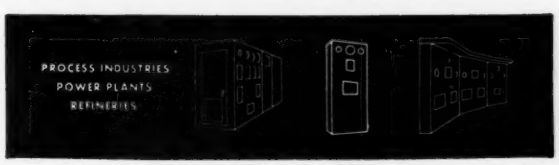

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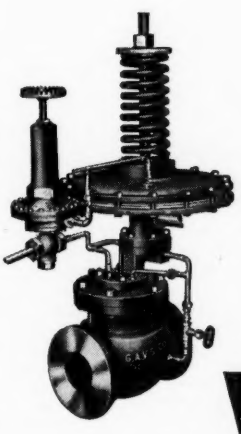

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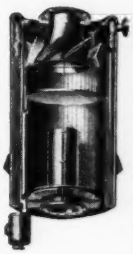

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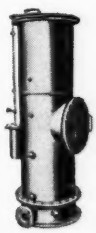

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POWER PLANT Construction News

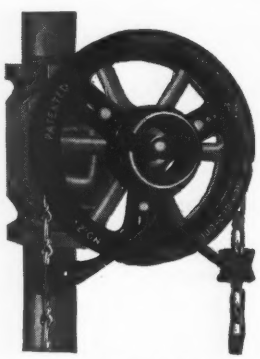
Gorgas, Ala.—Alabama Power Co., Birmingham, Ala., will begin work soon on new addition to No. 2 steam-electric generating station at Gorgas, to provide for installation of new turbine-generator, making sixth such unit at plant, high-pressure boiler and auxiliary equipment. No official estimate of cost announced—reported over $5,000,000, with extensions in transmission lines and other facilities.

North Little Rock, Ark.—Arkansas Power & Light Co., Pine Bluff, Ark., has plans maturing for expansion in Lynch steam-electric generating station near North Little Rock, with installation of turbine-generator, high-pressure boiler and auxiliary equipment for increased capacity. Cost reported close to $5,000,000.

Miami, Fla.—Florida Power & Light Co., Miami, is arranging financing through sale of bonds in amount of $10,000,000, proceeds to be used for expansion and improvements in power plants, power substations, transmission and distributing lines.

Cicero, Ill.—Cities Service Oil Co., Inc., 919 North Michigan Ave., Chicago, Ill., plans boiler house at new lubricating oil plant at Cicero, where tract of over 40 acres of land has been secured, fronting on Illinois Ship Canal. Project will comprise several main structures for compounding and blending, and group of miscellaneous units, and is reported to cost about $4,000,000. Construction will be placed under way at once. Executive offices of company are at 70 Pine St., New York, N. Y.

Hennepin, Ill.—Illinois Power Co., Decatur, Ill., has preliminary plans under way for new steam-electric power plant in vicinity of Hennepin, with turbine-generators, high-pressure boilers and auxiliary equipment for large capacity. Cost reported close to $10,000,000, with switching station and transmission lines.



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Detroit, Mich.—General Motors Corp., General Motors Bldg., Detroit, plans power plant at new technical center on 300-acre tract of land at Mound and 12-mi. Rds., near city. It will comprise a large group of 1- and multi-story buildings, entire project estimated to cost approximately $25,000,000. About 36 months will be required for completion. Smith, Hinchman & Grylls, Marquette Bldg., Detroit, are architects and engineers.

St. Louis, Mo.—Union Electric Co. of Missouri, 315 North 12th Blvd., has plans under way for new steam-electric power plant at junction of Mississippi and Mermac Rivers, St. Louis County, with initial capacity of 110,000-kw. Cost estimated about $26,000,000, with switching station, power substations, transmission lines and other facilities. Proposed to have ready for operation in 1952.

Sayreville, N. J.—Jersey Central Power & Light Co., Asbury Park, N. J., has plans under way for expansion in Raritan River steam-electric generating plant at Sayreville, with installation of turbine-generator, high-pressure boilers and auxiliary equipment for increased capacity. A similar project will be carried out at generating station at South Amboy, N. J. This is part of an expansion and improvement program during next 48 months, entire development to cost approximately $25,000,000.

Ithaca, N. Y.—New York State Electric & Gas Corp., Ithaca, plans expenditure of about $54,000,000 during next 36 months, for expansion and improvements in power plants and system, including increased generating facilities, power substations, transmission and distributing lines.

Raleigh, N. C.—Carolina Power & Light Co., Raleigh, is arranging fund of about $48,000,000 for expansion and improvements in generating plants and system during next 42 months, including installation of additional equipment for increased generating capacity.

Ashtabula, Ohio—Hooker-Detrex, Inc., oil-extraction and other solvents, care of Hooker Electrochemical Co., Buffalo Ave. and 47th St., Niagara Falls, N. Y., of which first noted company is a subsidiary interest, plans boiler plant at new chemical works near Ashtabula, where tract of about 25 acres of land has been selected. Project will comprise several processing and production buildings, and is reported to cost approximately $1,500,000. Work will be placed under way soon.

Oklahoma City, Okla.—Oklahoma Gas & Electric Co. has arranged financing in amount of $10,000,000, portion of proceeds to be used for expansion and improvements in generating facilities, power substations, transmission and distributing lines.

Allentown, Pa.—Pennsylvania Power & Light Co., Allentown, plans gross expenditure of approximately $92,500,000 during 36 month period, beginning in 1949, for expansion and improvements in power plants and system. Increased generating facilities will be provided, with power substations, transmission and distribution lines.

North Charleston, S. C.—West Virginia Pulp & Paper Co. has approved plans for near power plant at local mill, and will begin work soon. Construction will form part of an expansion and improvement program at plant to be carried out over period of several months, with total cost reported in excess of $4,000,000. Executive offices are at 230 Park Ave., New York, N. Y.

Belton, Tex.—Brazos River Transmission Electric Cooperative, Inc., Amicable Bldg., Waco, Tex., plans expansion in steam-electric generating plant near Belton, with installation of two new generating units, each with rating of 11,500-kw and auxiliary equipment. This is part of a general extension project to include construction of 11 new power substations and other operating facilities, estimated to cost about $6,480,000.

Salt Lake City, Utah—Utah Power & Light Co., Salt Lake City, has authorized plans for new steam-electric generating station on local site, with initial capacity of 60,000-kw. At later date, two additional units of like capacity will be installed. No official estimate of cost announced. Bechtel Corp., 220 Bush St., San Francisco, Calif., is engineer and will supervise construction.

Anacortes, Wash.—Skagit County Public Utility District, Mount Vernon, Wash., has plans in progress for new steam-electric generating plant near Anacortes, reported to cost approximately $3,000,000, with turbine-generator, high-pressure boiler and auxiliary equipment. Harza Engineering Co., 400 West Madison St., Chicago, Ill., is engineer.

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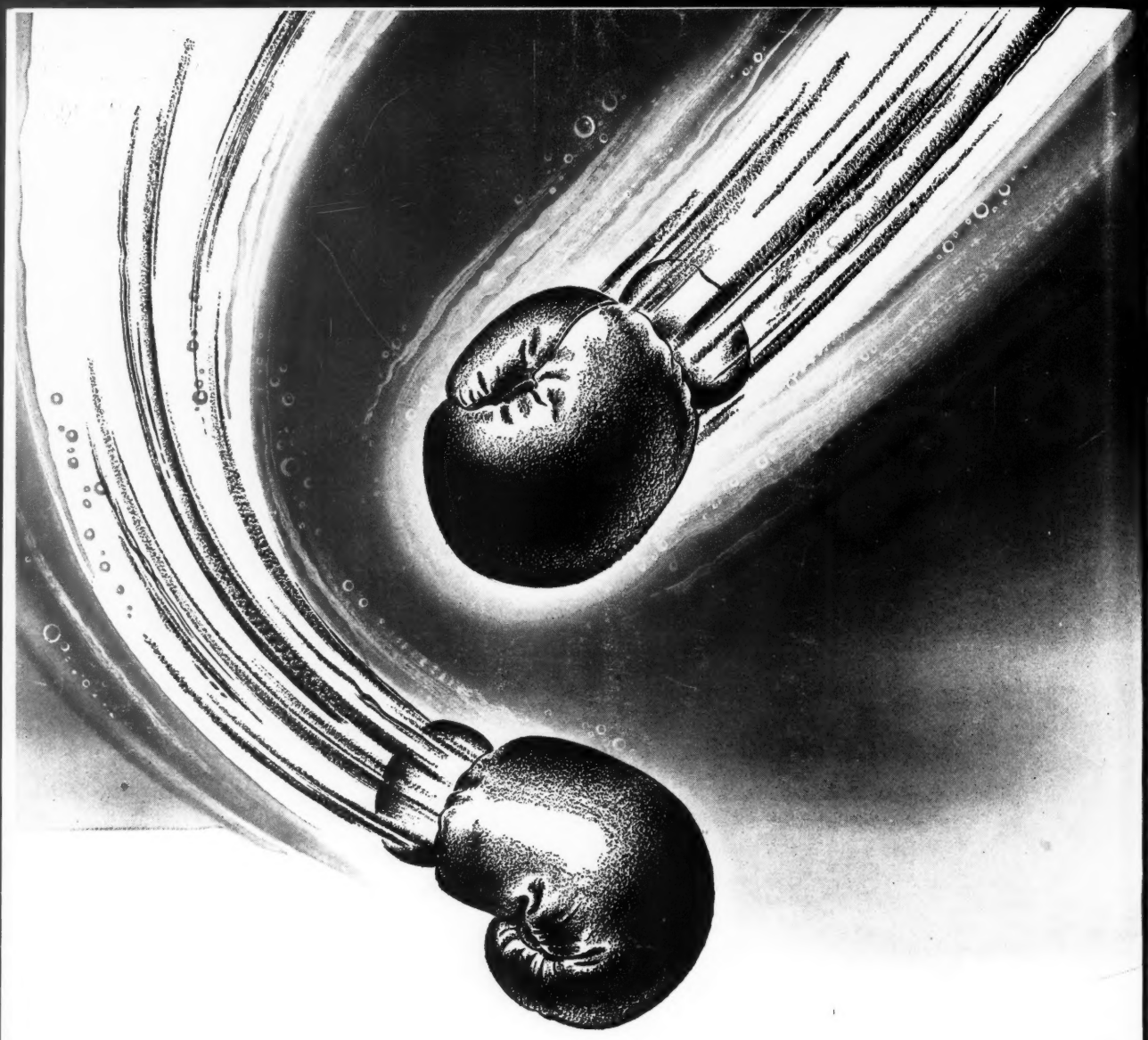

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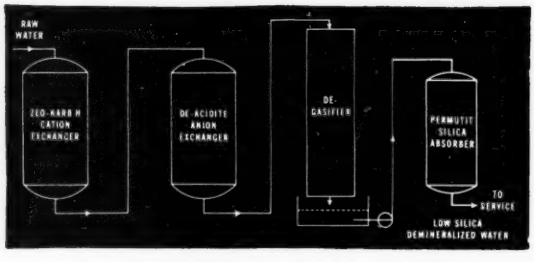

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